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DISEASES AND SURGERY

OF THE

GENITO-URINARY SYSTEM

BY

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VOLUME II

THE KIDNEYS AND URETERS

WITH 115 ENGRAVINGS AND 24 COLORED PLATES

PHILADELPHIA AND NEW YORK
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1908

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PART III.

THE KIDNEYS AND URETERS.

CHAPTER XVIII.

URINARY ANALYSIS AND TESTS OF THE CAPABILITY OF THE RENAL FUNCTION.

EXAMINATION OF THE URINE.

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Abnormal Constituents, Significance and Tests For.—Proteids: albumin, hemoglobin, mucin, fibrin. Carbohydrate: sugar.

Other Abnormal Constituents.—Biliary pigments.

Toxic Properties of Normal and Abnormal Urines.

General Considerations.—The knowledge which the surgeon should have of the urinary examinations must, at least, be sufficient to enable him to recognize for himself the presence and the degree of severity of the more important diseases, in the diagnosis of which urinary analysis plays the chief role. That is to say, he must be able to determine the presence and judge of the gravity of the different forms of Bright's disease of the kidneys, diabetes, the so-called crystalline urinary diatheses, renal hyperemias, pyelitis, malignant disease of the kidney, tumors of the bladder, and cystitis, of the existence of which the urine furnishes valuable, and sometimes the only, information.

Apparatus and Reagents Required.—In order to be able to make the necessary examinations of the urine, the practitioner should be provided with the following articles and reagents:

Apparatus.—Urinometer; an assorted set of 12 test tubes; 1 large and 2 small glass funnels; 2 glass stirring rods; 3 graduate glasses; a delicate weighing scale; 2 small porcelain dishes; 2 watch covers; a finely graduated thermometer; rack for test tubes; Bunsen burner or alcohol lamp; pipettes; urinometer glass; litmus papers; microscope coverglasses and slides; microscope; centrifuge; filter papers.

Reagents.—Nitric acid, C. P.; hydrochloric acid, C. P.; acetic acid; sulphuric acid; strong ammonia; saturated solution of barium nitrate; Fehling's solution; solution of silver nitrate (1 dram to 1 ounce); magnesium mixture (magnesium sulphate, ammonia chloride, āā 1 ounce; distilled water, 8 ounces; ammonia water, 1 ounce); solution of barium hydrate and barium nitrate; Knop's hypobromite of sodium fluid (100 grams sodium hydrate, dissolved in 250 c.c. of distilled water; add after cooling 25 c.c. of bromide); ferric chloride; ether; alcohol.

NORMAL CONSTITUENTS OF THE URINE.

Normal constituents.	Variations within normal limits.	Normal quantities.	Conditions causing such variations.
Urea.	16 gm. or 250 gr. in the 24-hour amount of urine secreted.	Secreted by healthy adult living a very regular sort of life; averages about 500 gr. in 24 hrs. Normal per cent. is 2 per cent., or 0.02 gm. per c.c., or 10 gr. to an ounce.	Diet, exercise, hard mental work. Climatic conditions.
Uric acid.		0.4 to 0.8 gm. in 24 hrs. by the healthy adult, 6 to 12 gr.	Relative to the amount of urine passed, but not necessarily indicating an excess of uric acid per se excreted, it may appear as a precipitate, as uric acid crystals or in combination as urates, in normal urine on standing and cooling, or after sweating, or when insufficient water is ingested.
Chlorides.		10 to 16 gm. by healthy adult per 24 hours.	Increased by ingestion of salt. Diminished by repose; increased by activity.
Phosphoric acid.		Amount secreted in 24 hours about 2.8 gm.	

ABNORMAL CONSTITUENTS OF THE URINE.

Proteids.—Albumin.—Albumin may be present in the urine of persons who have no appreciable lesion of the kidneys. Whether or not it can occur in the case of a person in sound health, is a question which is still debated.

In order to have albumin in the urine, one or more of the following conditions must exist: (1) Pathological changes must have taken place in the membranes in the kidneys which separate the blood from the urine, of such a character as to permit the passage through them of the serum albumin of the blood, which they do not do in their normal state. (2) Abnormally great pressure of the blood current in the kidneys, under which influence the albumin may be forced through the membranes. (3) A change in the quality of the albumin, owing to which it becomes more diffusible, and consequently more capable of penetrating the membranes and entering into the urine. (4) Albumin will also be present if hemorrhage occurs in any part of the urinary tract.

Of these conditions, the first is by far the most frequent, hence the presence of albumin in the urine more often than not implies the existence of renal disease, and we find it as one of the evidences of Bright's disease or other structural lesion of the kidneys in the *majority* of cases, but it may also occur in the other conditions named. A too rapid arterial circulation in the kidneys, as in active congestion, or a retarded one, as in passive congestion, are examples of the first of them, and changes in the character of the blood itself, as in certain forms of anemia, of the second.

TESTS FOR ALBUMIN IN THE URINE.—1. *The Heat Test.*—Fill a test tube half full of urine to which has been added as many drops of nitric or acetic acid as may be needed to insure its being made acid, but only just enough to give it a well-marked acid reaction. Boil the upper half of the urine in the tube. If this half becomes cloudy, it is because of the coagulation of albumin.

If the urine is made *too acid*, the albumin may fail to appear, because of having formed a soluble compound with the acid. If the urine is *not sufficiently acid*, the earthy phosphates may be precipitated and be mistaken for albumin, which they resemble. The addition of a little more acid will show the nature of the cloud made by them under these circumstances, by the fact of its disappearance when this is done.

2. *The Nitric Acid Test.*—Place a small quantity of urine in a wineglass, and allow an equal quantity of nitric acid to flow down the side of

the glass very slowly from a pipette, at the same time tilting the glass to one side and holding it steady. If albumin is present, a ring forms at the junction of the two liquids. The quantity of albumin may be approximately estimated by the density of the zone and by its thickness, provided the acid has been poured in very slowly and the glass has been held steady. If there is but a very small trace of albumin, it may not show at first, but will do so later on letting the test glass and its contents stand for a half hour.

In urines which contain a large quantity of the urates in proportion to the amount of the urine—as in concentrated specimens—these will be precipitated, and will also show a zone upon the addition of the nitric acid. This zone is not at the line of contact of the two fluids, but appears above it as a smoky, less well-defined ring of slightly grayish-brown color.

The urine should be filtered before making either the heat or the nitric acid test, for if it is cloudy, the albumin zone may be obscured.

When estimating approximately the quantity of the albumin present, the following rules will serve as guides: If the zone of albumin formed between the urine and the acid in the nitric acid test is transparent, or but moderately thick, when looking down upon it from above, if it is not granular, and if it is not wider than 2 to 3 mm., the amount of albumin may be reckoned as being much less than 0.5 per cent. (according to Ultzmann, usually about 1 pro mille). If, on the contrary, the zone is 4 to 6 mm. thick, dense, very white, and can be readily seen even when not held up against a black background, and if it presents a curdled appearance, the quantity of albumin is large—0.25 to 0.5 per cent. Finally, if a flocculent, white, dense ring forms; if more or less thick masses of albumin fall to the bottom of the glass, and when on stirring up the contents with a rod the whole liquid is converted into a thick substance resembling clotted cream, the amount of the albumin is very large, 1 to 2 per cent., or more.

The quantitative estimation can be accurately made by separating out the coagulated albumin, drying, and weighing it.

The quantity of albumin present in the urine from day to day in cases of renal disease—Bright's, etc.—is a gauge of the *progress* of the malady in one direction or the other, in any particular case. It cannot be taken as being necessarily a measure of the *seriousness of the disease*, for some of the most fatal forms of renal disease—chronic interstitial nephritis, for example—at times show but little albumin in the urine, and at times it is entirely absent; whereas, an acute parenchymatous nephritis may offer a far better prognosis, yet the urine from such kidneys is often heavily loaded with albumin.

One other source of albumin in the urine is the presence of blood or pus These may, and often do, come from the lower urinary passages, and, being albumin-containing substances, give, of course, an albumin reaction on the application of the above tests. In such cases it is not necessarily an indication of the existence of any renal lesion whatever.

In order to discriminate between the presence of albumin and the other substances which may give rise to misleading appearances in the urine, and which have been mentioned above, and to be able to estimate correctly the quantity present, practice with the tests is necessary, and especial care must be taken to observe the two precautions of pouring in the acid very slowly, in the nitric acid test, and of keeping the test glass perfectly quiet. If the urine is cloudy from the presence of bacteria, it must be cleared before making the albumin test. This can be done by precipitating them together with the earthy phosphates, which are thrown down on the addition of ammonium hydrate, and filtering the urine. The filtrate is then again rendered acid and tested for albumin.

The cloud produced by the earthy phosphates on heating an alkaline urine will dissolve on the addition of acetic acid, and thus reveal its nature, should the albumin test have been made in a urine not already acidulated.

Sugar.—Sugar exists in minute quantities in the normal urine. It may appear in it temporarily in connection with digestive disturbances, or from the too great ingestion of starchy or saccharine foods, and, again, following the administration of certain drugs—strychnine, the salicylates, turpentine, chloral, alcohol, phloridzin. It may also occur during certain acute maladies—typhoid and rheumatic fevers, and pneumonia.

The *persistent* presence of sugar in the urine is the expression and most characteristic evidence of the existence of grave disorders of the central nervous system, or of the liver or pancreas, whereby the functions of one or both of the organs have become seriously defective, diabetes mellitus being the name given to this condition.

TESTS FOR SUGAR IN THE URINE.—*The Copper Test with Fehling's Solution.*—The essentials in the performance of this test are that the testing fluid shall be of standard quality and shall not have undergone degeneration through having been kept too long or exposed to heat or bright light, and that in making the test the suspected urine shall be added, a few drops at a time only, and the test fluid boiled after each addition has been made.

Fehling's solutions are best kept separate until they are required for use, then mixed in equal parts to the quantity of 5 c.c. altogether.

Place this amount in a test tube and boil it. Add three to six drops of the suspected urine and boil again. Continue to repeat this until the

quantity of urine added equals that of the test fluid, boiling after each addition of the urine.

If in large amount, sugar announces its presence by the formation of a yellow or reddish-yellow precipitate. If none takes place on adding the first few drops, continue to add more of the urine, as already directed.

If boiled too long, a greenish opacity may appear in the urine, owing to the reduction of copper in the test fluid, even though *no* sugar is present; again, if the urine is alkaline, the earthy phosphates may be precipitated in the form of a thick grayish cloud. Albumin, if present, should be precipitated and filtered from the urine before testing for sugar, as it obscures the latter test if allowed to remain.

Quantitative Estimation of Sugar.—It is essential to make the quantitative estimation of sugar, since upon it depends the knowledge of the progress of the disease and the results of treatment in each case.

Test with Fehling's Solution.—Each 10 c.c. of the solution corresponds to 0.05 gm. of sugar. The urine should be diluted, 1 part to 10 parts of water, if sugar is in large amount; 1 to 5, if in small quantity. The specific gravity will be a good guide to this. If 1025, dilute 1 to 5; if 1035, dilute 1 to 10.

Place 35 c.c. of the test fluid in a flask of 150 c.c. capacity and fill the flask half-full by adding distilled water. Boil. From a graduated burette of 10 c.c. capacity filled with the urine to be tested, flow it into the boiling fluid in the flask, one drop at a time, until the blue color of the contained fluid fades; then very slowly, with an interval of several seconds between each drop, continue to add the urine from the burette until the color of the fluid in the flask has wholly disappeared and left it clear and transparent.

The precipitate should be allowed to gravitate from time to time to the bottom of the flask in order to judge if the blue color has wholly disappeared. For this reason the intervals between the addition of the drops of urine from the burette should be long enough to determine this fact.

When the color has wholly disappeared, the amount of urine that has been used to accomplish this is noted by reading it off on the graduated burette, and the calculation is then made on the basis that 0.05 gm. sugar is required to decolorize 10 c.c. of test fluid. To reckon the percentage of sugar, divide 5 by the number of cubic centimeters divided by 10 of the diluted urine used to decolorize the test fluid. Thus if 10 c.c. of the urine was used we should divide 5 by 1 in order to obtain the percentage of sugar, which in that case would be exactly 5 per cent.

Diacetic Acid.—This substance is liable to be mistaken for acetone. It can be distinguished from it by the fact that it gives a violet-red or brownish-red mahogany color when tested with a few drops of ferric

PLATE XXIV

FIG. 1

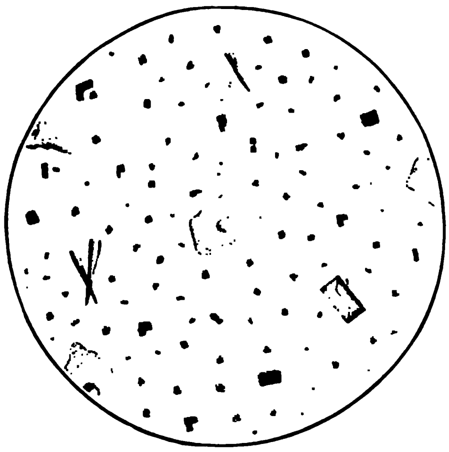


FIG. 2

FIG. 3

FIG. 4

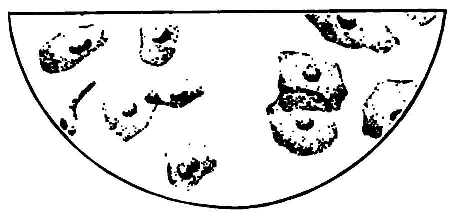
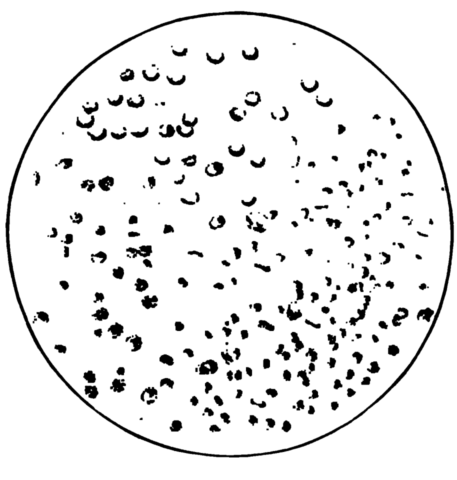


FIG. 5



VARIETIES OF EPITHELIUM. (Ultzmann.)

Figs. 1, 2, 3, and 4.—Epithelium from the bladder, the renal pelvis, and the ureter.
Fig. 5.—Red blood corpuscles.

chloride solution. The presence of diacetic acid in the urine is usually of grave import. It is frequently significant of impending coma in cases of diabetes mellitus.

Acetone.—Acetone in the urine does not necessarily indicate the existence of a pathological process, since it is found at times in small amounts in the urines of persons in good health. It is known to be increased by the ingestion of large amounts of animal food and of alcohol.

Clinically it is often found in cases of diabetes mellitus, acute fevers, and in autoinfection. Under these circumstances it is in larger quantity, and may be the cause of certain threatening symptoms, such as great excitement, delirium, in some instances followed by coma and death.

Ladd and Osgood[1] have made some interesting observations upon the amount of acetone as influenced by the administration of ether in surgical operations.

Epithelial Cells from Different Parts of the Urinary Tract.—The forms of the epithelial cells found in the urine and of their nuclei, and the number of the latter, are all suggestive or determinate of the part of the urinary tract from which they have been cast off. In some cases, however, it is impossible to assert with certainty just what part they have come from. The presence of cells of certain forms, and having nuclei of unusual size and form, are suggestive of the presence of a vesical tumor, for example. It is sometimes of value in determining the source of blood to find an excess of epithelial cells of one or another kind associated with the blood in the urine.

The different forms of epithelial cells found in the urine and the parts of the tract from which they come are shown and specified in Plate XXIV.

As is shown by the illustrations, many of the cell forms resemble each other so closely as to make it impossible to be sure to which part of the tract they belong. This is especially true of those which are from the renal pelvis and the prostate.

Bits of Tumors of the Bladder Found in the Urine (see chapter on Tumors of the Bladder).—In many cases of tumor of the bladder, bits of the surface of the growth are cast off and appear in the urine in forms which are absolutely characteristic. Their discovery is therefore of great value with reference to the diagnosis of the existence of a tumor in the bladder. It has no value, however, in informing us of the *nature* of the tumor from which the bits are derived, for they are from the periphery only of the neoplasm, and the base may possess a very different character from the surface.

Pyuria.—Pus appears in the urine in connection with all suppurative processes of any parts of the tract. In the urethra, it is most frequently, of course, seen in cases of acute and chronic gonorrhœa. It is present

in the bladder in all varieties of cystitis—calculous, tuberculous, gonorrhœal, or from alkaline decomposition of retained urine in cases of stricture of the urethra, and of prostatic hypertrophy. When from the kidney, the diseases that give rise to it are pyonephrosis, pyelitis, pyelonephritis, abscess of the kidney, and calculous nephritis.

Characters of Pus Cells in the Urine.—The pus cell, when present in neutral or acid urines, is round in form, about twice larger than the red blood corpuscle, and has several nuclei. The contents, which are finely granular, disappears on the addition of acetic acid, leaving the nuclei standing out very clearly to view.

In urine which has undergone alkaline fermentation, the pus cells are changed, run together, forming dense masses, converting it into a thick, coagulated body, which, in marked instances, has very much the same consistency as the white of an egg.

This is not to be mistaken for mucus, which does not behave in this way, and which, *unlike* the pus, does *not* give an albumin reaction.

In the urines containing pus in large quantity, and which have undergone alkaline fermentation, the pus sinks rapidly to the bottom of the vessel. When it occurs in small amounts, and in acid urines, it may take a good while to settle.

The different characters just referred to are more or less distinctive of cystitis and pyelitis, respectively. There are some exceptions, however, to this rule, viz., the cases in which there exist large pus pockets in the kidney. It is not usual, however, to have the very thick masses of ropy pus in the renal condition, such as commonly occur in cases of chronic cystitis with alkaline decomposition of the urine in the bladder.

The only sediments at all likely to be confused with pus are the amorphous urates and the phosphates. Heat dissipates the former, and the addition of a few drops of acetic acid the other; whereas, neither test causes pus to disappear.

Blood in the Urine (Hematuria).—Blood appears in the urine as the result of trauma, renal congestion, or some pathological lesion situated in the urinary tract. It occurs in one of two forms: (1) That in which the corpuscles are present. (2) That in which blood coloring matter alone is present. In the latter condition the color of the urine varies between dark brown and almost black. It is due to the presence of hemoglobin. The sediment in these cases consists of epithelium and detritus, both of a brownish color. The absence of the corpuscles is owing, in some instances, to their having been destroyed by remaining for a long time in the urinary passages.

The following are the more important of the conditions in connection with which hematuria arises:

Active or passive congestion of the kidneys, traumatism of any part of the urinary tract (with some persons, very mild forms of traumatism are enough to cause blood to appear in he urine, *e. g.*, riding a hard-gaited horse. Renal and vesical calculi may be regarded as one form of trauma, both of which give rise to bleeding. Other conditions are: tuberculous lesions of kidneys or bladder, malignant disease of the same, acute inflammations of any part of the urinary tract, abscesses opening into it.

Features of Hematuria by Which the Source of the Blood Can Be Determined with Greater or Less Certainty.—The most important thing in the examination of the urine in cases of hematuria is to determine the source of the bleeding in the urinary tract. In many instances this can, in some it cannot, be done. The more essential points to be noted in this connection are as follows:

1. The color which is given to the urine by the blood.

2. Whether or not it is evenly distributed throughout the whole urine, so that as much color is seen in the first as in the last third of it when passed in three separate parts.

3. The quantity present. Whether this be constant, or intermittent, affected by exercise or not.

4. The character of the red blood corpuscles; whether spherical or biscuit-shaped, crenated or smooth, lying in rouleaux or not.

5. The association with the blood of special elements of one sort or another, viz., either an excess of normal elements, or the occurrence of pathological ones, *e. g.*, epithelial cells of special character denoting the part of the urinary tract from which they have come; crystals, bits of tumors of the bladder, casts, and pus cells.

6. The chemical reaction of the urine in which the blood is present.

7. The specific gravity and the presence of a larger quantity of albumin than the blood will account for.

It should be remembered that in many respects the statements made below are of a general character and not intended in all instances to be taken as positive.

The significance or suggestion, at east, which these different characteristics of the blood and other features of the urine associated with it convey are as follows:

1. *Color of the Urine.*—If the urine is of bright red or pink color, the inference, in a general way, is that the source of the bleeding is in the lower urinary tract. The reverse of this statement, viz., that dark colored urine implies that the source of the blood is from the kidneys, is not necessarily true by any means, for the darker color may be due to the retention in the bladder for a long time of blood which has arisen from

the bladder or from the prostate or the posterior urethra, and has been kept in the viscus because of obstructive enlargement of the prostate, or stricture of the urethra.

Very dark urines in cases of hematuria are owing sometimes to the presence of the blood-coloring matter in large amount, as is sometimes seen in cases of hemoglobinuria, or when the blood corpuscles have been destroyed by having the urine long retained in the bladder, or in a sacculated kidney, in which alkaline decomposition of the urine has taken place. Again, the color is dark when the blood is present in large quantities.

2. If there is an evenly distributed color throughout the whole amount of the urine passed at each act of urination, it suggests that the kidneys are the source of the bleeding rather than the lower urinary tract, or that the blood-coloring matter alone stains it. If, on the contrary, the color of the last of the urine when divided into three separate parts as it is passed from the bladder is deeper or brighter red than that of the first or second, the chances are that the blood proceeds from some intravesical condition. If the color is more marked in the first of the three parts thus separated, the source of the blood is probably the urethra or the prostate.

3. *The Quantity of Blood Present.*—What has just been said with respect to the color of the urine applies also to the quantities of the blood present, since the variations of the one correspond, generally speaking, to those of the other. Thus the larger the amount of the blood, especially if it be from the kidney or bladder, the deeper red or brown will the color be. If, however, the color is dependent on the presence of hemoglobin, as in case of hemoglobinuria, this does not hold good, for there is then no means of measuring the amount of blood which this constituent in the urine would represent. In cases in which the urine is retained for a long time in the bladder, its color may be dark even though it contains but a small quantity of blood.

The largest quantities of blood are seen, as a rule, in connection with tumors of the bladder and with traumatisms of one or another part of the urinary tract. Except in the conditions just named, the quantity of blood does not give a very clear indication of the part from which it comes. If increased by exercise, whatever may be the amount present, the suggestion is that renal or vesical calculus are the causal agents of the bleeding.

The quantity of blood is seldom sufficient to form clots in the bladder or kidney, except in cases of injury, and in some cases of tumor of the bladder and of vesical calculus. In a few instances, acute nephritis and malignant disease of the kidney give rise to severe hemorrhage.

4. *The Character of the Blood Corpuscles.*—If the red blood corpuscles retain their natural biconcave form and preserve their light reddish color, it is safe to say that the blood has proceeded from the urethra, or has been mixed with the urine very shortly before its passage. (Plate XXIV, 5.) If they are spherical, it is thought to be a sign that they have remained a long time in the urinary tract, and, having imbibed urine, have become distended to this form. (Plate XXIV, 5.)

If the urine is alkaline, and has been retained for a long time in the bladder, as in the case of residual urines, in connection with prostatic hypertrophy, the red blood corpuscles are destroyed and the blood-coloring matter alone remains and gives the color to the urine.

The crenated red blood corpuscles usually occur in an acid urine, and hence are more apt to be associated with the non-suppurative conditions of the bladder than with those that produce pus.

5. *The Association with Blood in the Urine of Elements Characteristic of Special Parts of the Urinary Tract.*—This is the most significant evidence of the source of the blood in connection with the examination of the urine in cases of hematuria. If there be an excess of the epithelial cells belonging to some special part of the urinary tract, bladder, prostate, renal pelvis, or renal tubules in the form of epithelial casts, the inference as to which of the parts of the tract the blood is coming from is to be drawn according to the character of the epithelial cells found in the individual cases.

If we find the blood associated with *crystals* of one kind or another in an acid urine, the inference suggested is that the kidney is the source of the blood.

The same is true if casts—particularly if blood casts—occur in association with the blood; whereas if the urine is alkaline, if it contains pus, bladder epithelium, and crystals of the triple phosphates, the probability is that the bladder is the source of the bleeding, though the same conditions are seen in some cases of pyonephrosis. If masses of cheesy pus are associated with blood corpuscles and small blood clots in an acid urine, there is a good chance that a tuberculous lesion of the kidney is the source of the trouble.

If blood occurs, in microscopic quantities only, is increased by exercise, and is constantly, or nearly constantly, present in an acid urine, and especially if more or less casts and epithelium from the renal pelvis appear, the chances are very great that the bleeding has been excited by a persistent crystalline deposit or by calculus of the kidney. If associated with characteristic pain, we can be practically certain that such is the case.

The finding of typical bits of the surface of a villous tumor of the bladder betrays immediately the source of the blood.

6. *The Reaction of the Urine.*—It may be said in a general way that blood occurring in an acid urine and with but a small amount of pus, or none at all, is more likely to proceed from the kidney than from the bladder. This, however, is subject to many exceptions; for instance, we may have a vesical calculus which will give rise to hematuria without producing any pus, and in an acid urine; and again, the urine may be alkaline, in the case of a renal calculus of secondary formation, and contain enough pus to cause it to resemble the cases in which it, as well as the blood, are of vesical origin.

The reaction, therefore, is less significant of the source of the hematuria than some of the other factors already discussed.

7. *The Specific Gravity and Greater Quantity of Albumin than the Blood Will Account For.*—A low specific gravity and albumin in excess of the blood present, either or both, would suggest a renal origin of the bleeding.

Form of Blood Clots.—The form and color of blood clots are more or less characteristic in some cases. This is particularly true of the clots formed in the ureters, which are apt to be shaped like a slate-pencil, and, if they have remained a long time in the ureter, they may also have the color of one.

Crystals.—Significance and Varieties.—Crystalline sediments always fall to the bottom of the vessel in which they are contained more or less rapidly, according to the degree of density of the urine, settling quickly in the thinner and more slowly in the concentrated urines.

These urinary sediments have a variable clinical significance. Some of them are the expression of the existence of serious lesions; others, again, may be present for a long time without thereby indicating any important disturbance of general health, or in the urinary tract. As an example of the latter fact, the appearance of the amorphous urates that is so commonly noticed when the urine has been standing in a cold room for some time may be mentioned.

Some urines will, for long periods, show a deposit of the amorphous phosphates, crystals of oxalate of lime, or of uric acid without the formation of calculus taking place in either bladder or kidney; with others, the contrary is true. The persistent, spontaneous, precipitation o crystalline products in the urine, of whatever sort they may be, is th expression of an abnormal performance of the processes of assimilatio and of metabolism, and does not occur in an individual who is in soun health. (We have discussed the different so-called crystalline diathes in the chapter on Renal Calculus.)

PLATE XXV

FIG. 1

FIG. 2

FIG. 3

FIG. 4

FIG. 5

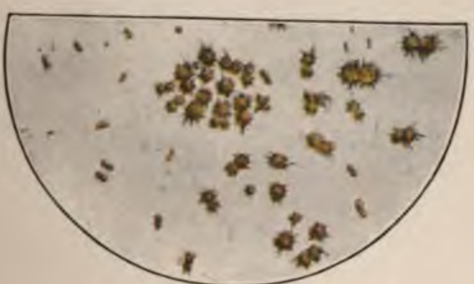


FIG. 6

URINARY ANALYSIS. (Ultzmann.)

Figs. 1, 2, 3, and 4.—Different forms of crystals of uric acid.

Fig. 5.—Crystals of urate of ammonium.

" 6.—Crystals of urate of ammonium and triple phosphate crystals.

PLATE XXVI

FIG 1

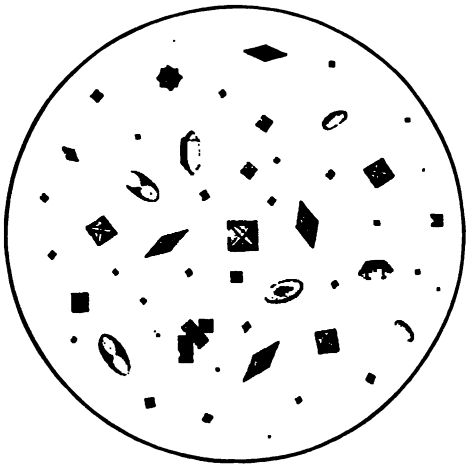


FIG. 2

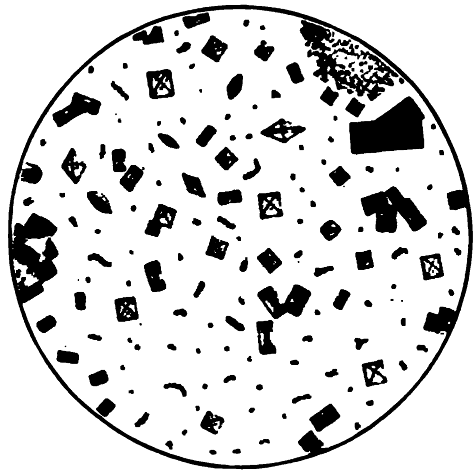


FIG. 3

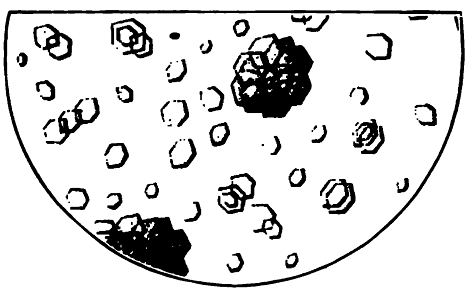
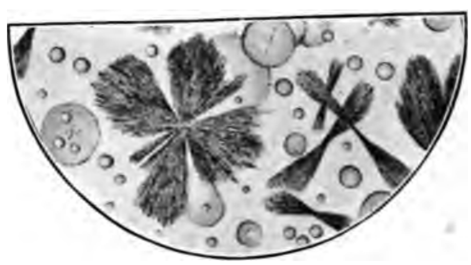


FIG. 4



URINARY ANALYSIS. (Ultzmann.)

Figs. 1 and 2.—Crystals of oxalate of lime.
Fig. 3.—Crystals of cystin.
" 4. Crystals of leucin and tyrosin.

PLATE XXVII

FIG. 1

FIG. 2

FIG. 3

FIG. 4

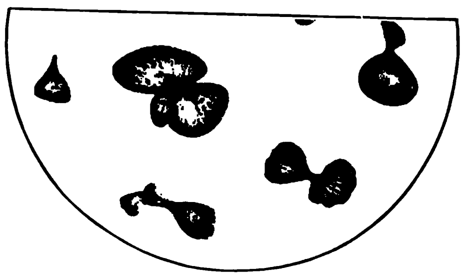


FIG. 5

URINARY ANALYSIS. (Ultzmann.)

Figs. 1 and 2.—Crystals of the triple phosphates. Fig. 1 is the common form.

Fig. 3.—Crystals of phosphate of lime.

" 4.—Crystals of urate of sodium.

" 5. Amorphous urate of sodium.

PLATE XXVIII

FIG. 1

FIG. 2

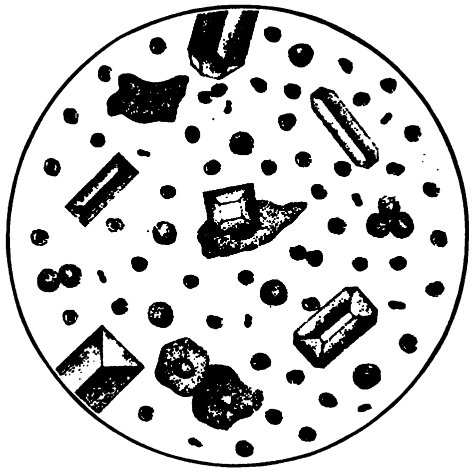


FIG. 3

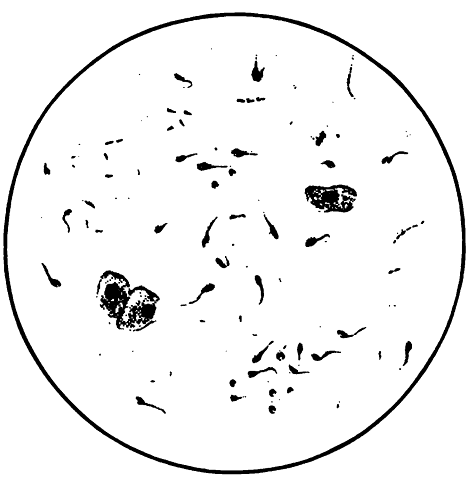


FIG. 4

URINARY ANALYSIS. (Ultzmann.)

Figs. 1 and 2.—Sediment of chronic cystitis. Fig. 2.—Moderate bleeding.
" 3 and 4.—Spermatozoa and the yeast fungus.

The Physical Characteristics of the Urinary Crystals.—The following crystals appear in the urine:

In Acid Urines.	In Alkaline Urines.
Uric acid.	Urate of ammonia.
Oxalate of lime.	Triple phosphates.
Cystin.	Phosphate of magnesia.
Tyrosin.	Phosphate of lime.
Urate of sodium. (Plate XXVII, 4.)	Carbonate of lime.

Uric Acid.—Some of the more frequent forms of uric acid crystals occurring in natural precipitation are shown in Plate XXV, 1, 2, 3, 4.

Oxalate of Lime.—Oxalate of lime crystals are shown in Plate XXVI, 1 and 2.

Cystin.—Cystin crystals are shown in Plate XXVI, 3.

Tyrosin and Leucin.—Tyrosin crystals are shown in Plate XXVI, 4.

Urate of Ammonia.—Crystals of urate of ammonia are shown in Plate XXV, 5 and 6.

Triple Phosphates.—Crystals of triple phosphates are shown in Plate XXVII, 1 and 2, and Plate XXVIII, 1 and 2.

Neutral Phosphate of Lime.—Crystals of neutral phosphate of lime are shown in Plate XXVII, 3.

Amorphous Urate of Sodium are shown in Plate XXVII, 5.

Phosphate of Lime.

Carbonate of Lime.

Plate XXVIII, 3, shows spermatozoa. Plate XXVIII, 4, shows the yeast fungus.

Casts.—Casts may be significant of simple hyperemia or of renal irritation produced by the mechanical friction from crystals, but their presence usually indicates more or less serious organic disease of the kidneys, especially if they are associated with albumin.

There are *false* as well as *true* casts. The false ones are structures which, for the most part, consist of mucous shreds, and may come either from the bladder or the kidney. They may be distinguished from the true casts by the marked variations of their caliber, by their absence of square-cut or distinctly rounded ends, by their greater length, and by their not having clear-cut outlines or epithelial cells and granular elements.

The following are the casts which are found in the urine:

Epithelial blood, granular, hyaline, waxy, and the so-called cylindroids.

1. **Epithelial Casts.**—This form of cast represents an exfoliation of the epithelium of the renal tubules. The cells have rather ill-defined

outlines in many instances, and present a granular contents. They are also more or less swollen. (Plate XXIX.)

2. **Hyaline Casts.**—Hyaline casts represent the exfoliated lining of the renal tubules. They are transparent and devoid of all other renal elements. (Plate XXX, 1.)

Epithelial casts are seen in cases of acute desquamative nephritis, such as occurs in connection with scarlet fever and in the form of Bright's disease known as chronic parenchymatous nephritis.

3. **Bacterial Casts.**—In cases of chronic cystitis and of suppurative conditions of the kidney in which bacteriuria is present, collections of bacteria resembling casts in form are sometimes seen.

4. **Blood Casts.**—Blood casts are represented by red corpuscles which adhere to the exterior of the cast-off linings of the renal tubules. They are formed in the conditions in which hemorrhage takes place within the renal tubules, such as acute congestions and inflammations, and hemorrhagic infarctions of the kidneys. (Plate XXIX, 3.)

5. **Granular Casts.**—Granular casts simply represent the tubular linings to which have adhered the detritus of pus, blood, or epithelial cells of the kidney. They are usually designated as coarse, fine, light, and dark granular casts. They are frequently broken, and appear only as parts of the casts. (Plate XXIX, 2, and Plate XXX, 3.)

Their presence is usually suggestive of rather serious organic degenerative lesions of the kidney, especially acute and chronic parenchymatous nephritis. (Plate XXX.)

6. **Fatty Casts.**—These consist of a hyaline membrane, to the outer coating of which numbers of fat globules of varying size adhere. They occur in the convalescent stage of acute, and also in chronic, parenchymatous nephritis.

7. **Waxy Casts.**—This variety of cast presents a thick waxy-looking body and a faintly yellowish color tone. They may be likened to large, heavy hyaline casts. They occur in chronic interstitial and in amyloid nephritis. (Plate XXX, 4.)

Summary of Characters Presented in Hyperemia and Different Forms of Bright's Disease.—Active Hyperemia.—Usually dependent upon direct irritation of the kidney, such as may be produced by urpentine or cantharides. Again, as the first step in an acute parenchymatous nephritis (acute Bright's). Also seen in connection with acute fevers and the concentration of the urine which accompanies them.

Characters of the Urine.—Color high; specific gravity high; solid relatively and often actually increased; quantity of the urine diminished albumin a trace; sediment; a little blood; a few blood and epithelia casts; renal epithelial cells. The renal epithelial cells come chiefly from

PLATE XXIX

FIG. 1

FIG. 2

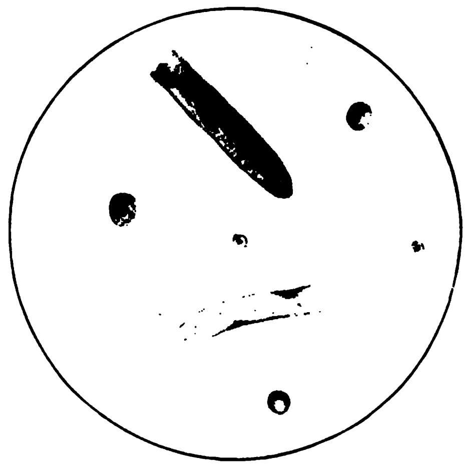
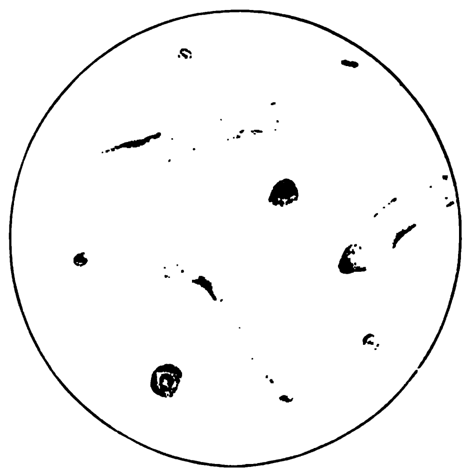


FIG. 3

FIG. 4



URINARY ANALYSIS. (Ultzmann.)

Fig. 1.- Epithelial casts seen in acute desquamative nephritis.
" 2 and 4.—Hyaline casts from renal congestion and chronic nephritis.
" 3.—Coarse granular casts from acute nephritis, with some blood corpuscles.

PLATE XXX

FIG. 1

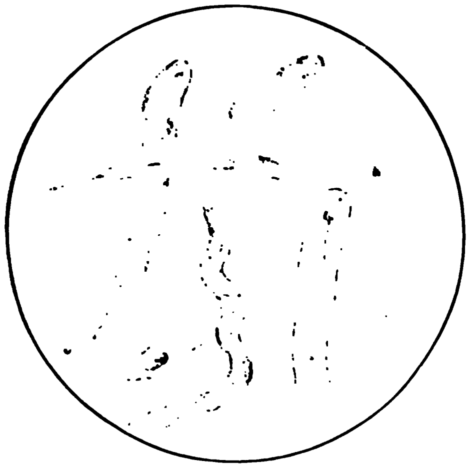
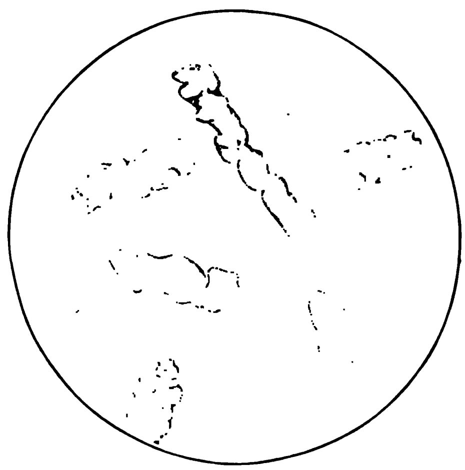


FIG. 2

FIG. 3

FIG. 4



URINARY ANALYSIS. (Ultzmann.)

Figs. 1 and 2.—Hyaline casts. In Fig. 2 they are covered with crystals of urate of ammonium.

Figs. 3 and 4.—Fine granular and waxy casts. Fig. 3 is from a case of advanced chronic Bright's disease. Fig. 4 is from a case of amyloid disease.

the collecting renal tubules. They are large and usually more than in the acute parenchymatous condition.

Passive Hyperemia.—Produced by anything which obstructs the venous flow from the kidney.

Quantity of the urine diminished; color high; specific gravity high; sediment slight; albumin a trace; urate zone in nitric acid albumin test is usually well-marked; solids slightly diminished. If amorphous urates are present the sediment is large.

Sediment.—May be a few blood corpuscles. Hyaline and fine granular casts of small caliber. No excess of renal epithelium.

Acute Parenchymatous Nephritis (Acute Bright's).—Acute inflammation, chiefly of the tubular elements of the kidney. It is often seen in association with scarlet fever.

The Urine.—Quantity diminished; color dark; reaction acid; specific gravity diminished or increased according to the degree of tubular obstruction offered by the exfoliated products. The solids are, in a corresponding manner, either diminished or increased. Chlorides and phosphates diminished; albumin in large amounts up to 1.5 per cent. If the case terminates fatally these characters of the urine are more marked, and there is a diminishing quantity of urine. If recovery takes place the quantity of the urine increases and albumin becomes less.

Sediment.—Abundant in the first stage, and of a brown color. Blood corpuscles in spherical form, and large quantities of renal epithelium are present.

Casts.—Brown, granular, epithelial, and occasional hyaline and fibrinous casts.

In *convalescence,* a diminution in the number of casts, a relative increase of hyaline, and the appearance of fatty casts. Quantities of urine and of solids increase. The amount of the urine is above the normal. The albumin is diminished to a trace.

Chronic Parenchymatous Nephritis.—The condition may be the residue of the acute form of the disease, or it may begin insidiously. It is also seen in association with pulmonary tuberculosis, syphilis, and amyloid disease.

The Urine.—Quantity diminished; color high; specific gravity high; reaction acid. Sediment abundant, and consists chiefly of amorphous urates. Solids relatively increased. Albumin exceeds in quantity that found in connection with any form of renal disease; it sometimes reaches 5 per cent.

Sediment.—Casts are chiefly fatty and granular; there are also more or less hyaline and sometimes waxy casts to be seen. In the cases in which the patients survive until the kidney begins to atrophy, as it does

in its later phases, the urine becomes indistinguishable from that of chronic interstitial nephritis.

Interstitial Nephritis.—The most frequent and the most fatal form of renal disease. It is very insidious in its approach and in its course. Is apt to be marked by frequent urination at night.

The Urine.—Quantity increased; specific gravity low; sediment slight and settles slowly; color pale; solids diminished; albumin a trace, often absent.

Sediment.—Hyaline and fine granular casts only in the early and waxy casts in the late phases of the disease.

Amyloid Disease of the Kidney.—The process begins in the arterioles. Increased nocturnal urination is apt to be a symptom. From the urine alone the condition cannot be distinguished from interstitial nephritis.

The Urine.—Quantity of urine large; specific gravity low; solids diminished; color pale. The sediment is more apt to have waxy casts than that of interstitial nephritis.

THE PHLORIDZIN TEST.

This test rests upon the assumption that the epithelial cells of the renal tubules are the only elements in the body which have the power to separate sugar from the drug phloridzin.

Could this fact be absolutely established the test would be of great value, since it would show the functional capability of the kidney with respect to both its epithelial chemical activity and also the permeability of its membranes; that is to say, in order to have the phloridzin reach the cellular elements of the epithelium the membrane interposed between them and the blood current must be sufficiently permeable to allow the drug to pass through them; and if the amount of sugar which has been established as the standard quantity that is found in the urine after the administration of phloridzin when the kidneys are normal is found in it, it demonstrates the normal permeability of the renal membranes and the normal degree of functional activity of the epithelial cells as well.

But, unfortunately, the assertion with regard to the sole proprietorship in the process of sugar reduction residing in these epithelial cells is rendered very doubtful by an experiment of Domenicis. In this experiment, a known dose of phloridzin was given to a dog, and a certain quantity of sugar was found in the urine and also in the blood. The test was repeated, with similar results. Some days later both kidneys were removed from the animal and the test was repeated as before. It then

appeared that a somewhat larger quantity of sugar was present in the blood than before the kidneys had been removed. This showed that some other part of the organism than the kidneys must also possess the power of separating sugar from the drug.

In a general way, however, it must be conceded that the test is not without value. At the least, it may be accepted as strongly suggestive of functional insufficiency when the standard amount of sugar is not found in the urine after the administration of phloridzin. The technique of the test is as follows:

A subcutaneous injection of 5 milligrams of sterilized phloridzin, for persons of moderate size and weight, and twice this amount for those who are of unusually large size and weight, is administered. If the kidneys are functionally normal, sugar should appear in the urine half an hour after the drug has been administered. If no sugar appears in the urine within the first hour, or none at any time, serious disease of the kidneys probably exists. If but a small percentage is found in the second half hour, this fact is taken as an indication of renal insufficiency in greater or less degree. The bladder should be emptied when the subcutaneous injection of the drug is made.

The drug is perfectly harmless, and injections may be repeated from time to time without injury.

The writer[2] made a series of observations with regard to the phloridzin test with special reference to (1) the amount of sugar eliminated by the kidneys within a specified time after phloridzin is administered; (2) the effect of ether anesthesia upon the renal function, as indicated by the amount of sugar eliminated by the kidneys during its administration, as compared with that produced when the patient was not anesthetized.

Among the results of these observations, which were made in 70 cases, were these: in 20 cases in which the kidneys were believed to be normal the average amounts of sugar shown at the end of the first and of the second half hours, respectively, when the patients were not anesthetized, were 0.42 per cent. and 0.36 per cent. At the same times, with the same individuals under ether anesthesia, the amounts of sugar were, respectively, 0.68 per cent. and 0.53 per cent. In 13 other cases in which renal disease was known to exist the same experiment showed the average amount of sugar for the whole number, tested at the end of the first and second half hours, when the patients were not anesthetized, to be 0.21 per cent. and 0.20 per cent.; while that of the corresponding tests, made during anesthesia, gave 0.22 per cent. and 0.20 per cent; that is to say, the effect of anesthesia would appear to be a stimulation of the functional activity of the kidneys when they are normal. When they are diseased, however, the existence of the disease was shown not only

by the less amount of sugar in the urine in the absence of anesthesia, but also by the failure to show an increased activity during its administration, as compared with the cases in which the kidneys were thought to be normal.

CRYOSCOPY.

Cryoscopy is the test by which the molecular concentration of different fluids is determined. The term molecular concentration means the number of solid molecules held in solution in a given fluid.

The determination of the molecular concentration of a fluid is arrived at by establishing the degree of cold required to freeze it, as compared with that which is required to freeze distilled water, it having been discovered that the freezing point of liquids bears a direct relation to their molecular concentration, and varies in accordance with variations of the molecular concentration of each of them, respectively. The law which governs these variations is: that the greater the number of solid molecules contained in solution in a liquid the greater is the degree of cold that is required to freeze it as compared with that at which distilled water congeals; that is to say, *the greater the molecular concentration of a fluid the lower will be its freezing point.*

The application of this law for the purpose of determining the existence of disease or functional incapability of the kidneys, was in large measure due to the studies of Koranyi, of Budapest; later, its value and its sources of error in this respect were more fully tested by Kümmel, Albarran, Achard, Bernard, Casper, Richter, and others. The test is made by determining the exact freezing points of the blood and the urine of the individual, the capability of whose renal function is to be estimated, and comparing them with that of distilled water.

In health, and when the kidneys are abstracting the normal number of solid molecules from the blood, the freezing point of the latter fluid is found to be a very constant one, varying only between 0.55° and 0.57° C. below the zero mark, the latter being taken as that of distilled water.

A wider variation is observed in the freezing points of the urine under the same circumstances; hence the cryoscopic test, if applied to it alone, is of but little value as an indication of the functional capability of the organs with respect to the number of molecules elaborated by them from the blood, and, to be of service, the test must be simultaneously applied to both the blood and the urine of the individual the integrity of whose renal function is in question. Furthermore, the freezing points of both fluids are influenced in some degree by the amount of fluid

ingested at different times, and the corresponding changes that occur in the quantity of the urine.

The freezing points of urines from normal kidneys varies between 1.2° and 2.3° below the zero mark.

It may be said in a general way that if the freezing point of the blood is 0.58° or lower, and that of the urine is 1° or higher (by higher, meaning nearer the freezing point of distilled water), and if a quantitative test of urea shows it to be below the normal amount which the kidneys eliminate when not diseased, we may safely conclude that the organs are damaged by one or another sort of pathological condition to a point at which their functional capability is seriously compromised.

The most practical feature of this test is with reference to the performance of nephrectomy. Before doing this operation we must be satisfied, so far as it is possible to learn it, of the functional capability of the opposite kidney, which will be called upon, after the removal of its fellow organ, to take upon itself the entire work of the renal function, and which must be capable of doing this if the operation is to be done with safety.

Whether or not the other kidney will be capable of carrying on a sufficient degree of functional work to maintain the life of the individual after one kidney has been taken away, can only be determined by testing the urines of each of the kidneys drawn from them individually by means of the ureteral catheter. It is the custom to do this in all cases at the present time before performing the operation of nephrectomy. A striking lowering of the operative mortality attending the operation has been observed since this practice has been adopted.

Manner of Performing the Test.—The Beckmann apparatus is that which is used for making the cryoscopic test. It consists of a large jar, containing a mixture of cracked ice and salt, and a glass cylinder or large test tube, which is held by an upright iron rod to which a sliding arm is attached, the further end of which is provided with a semicircular pair of branches which embrace the test tube. By this means the tube can be raised or lowered at will by shifting the arm up or down upon the upright bar.

The large test tube is used as a receiver for a second and smaller one, which contains the fluid to be frozen. The latter is provided at its open end with a well-fitting circular cork perforated by a hole in its centre, through which the thermometer can be passed, and by which it is held in such a position within the tube that it is equidistant from its sides and directly in the centre of the tube.

The thermometer is a very accurately graded instrument, the scale of which is divided into $\frac{1}{100}$° C., and having an exactly correct zero point.

Twenty cubic centimeters of the blood or urine to be tested is placed

in the inner or smaller tube, and the *bulb* of the thermometer should be completely covered by the fluid. The two tubes—the smaller one within the larger, and the thermometer within the former, with the bulb immersed in the fluid to be frozen—are now pushed well down into the salt and ice mixture until the latter is nearly on a level with the upper end of the tube.

The liquid within the small tube and the salt and ice mixture in the large jar should be stirred slightly from time to time during the test.

As the fluid begins to freeze, the column of mercury at the moment at which the fluid congeals rises, owing to the heat which is liberated in the process, and remains stationary for a moment. This is the true freezing point, and is that which is to be recorded as such in making the test.

It is questionable how much value this test has in the practical daily routine of the surgeon's clinic. It is not easy to do it with such accuracy that its results can be relied upon, and it is always to be remembered that it should not by itself be regarded as a sufficient demonstration of the state of the renal function. If taken in connection with the other methods of testing the capability of the renal function it doubtless is a valuable additional means of estimating it.

Sources of Error.—Two points must be carefully observed:

"1. The bulb of the thermometer must be completely immersed in the fluid to be examined, without, however, touching the bottom or the sides of the glass cylinder; in other words, the mercury must be completely surrounded by the freezing medium, so that neither the warm air stratum above nor the cold glass surface below influences the effect of the heat given off at the moment of freezing.

"2. The fluid must be kept in constant motion by means of the platinum rod. The highest point reached by the mercury is the freezing point.

"The fluid should be thawed several times and re-frozen to prove the correctness of the result."

Practical Experience with the Test.—Some of the practical observations made by Kümmel are as follows: In a number of cases of chronic nephritis, of ascending pyelonephritis, of bilateral renal tumors and renal tuberculosis, in which the bilateral distribution of the diseases was proved either by autopsy or operation, the blood concentration was found to be always higher than normal, which was indicated by the lowering of its freezing point to 0.58°, or more. In the larger number of the cases, it was found to be between 0.6° and 0.65°. In a number of instances the lowering of the freezing point was very striking, just at the beginning of uremic attacks. In almost all the cases a coincident decrease of the molecular concentration of the urine took place. In

the majority of the latter the figures varied between 0.9° and 0.3°. Occasionally 1° and more were temporarily observed in the urinary variation.

The freezing point of the blood may be lowered in connection with certain diseases, the kidneys, nevertheless, being normal. In fevers and with anemic patients whose kidneys were normal there was no instance in which the freezing point showed a lowering of the molecular concentration of the blood. In fever, with normal kidneys, the freezing point of the blood was elevated from 0.02° to 0.03°, which does not indicate disturbed kidney function.

In but one case of abdominal tumor did Kümmel find a lowering of the freezing point of the blood. In that instance the ureter of one side was compressed by a large ovarian cyst.

Kümmel places the limit of variation of 0.6° from the normal number as the limit beyond which it is extremely hazardous to do nephrectomy.

The Freezing Point in Anuria.—The very interesting observation made by Israel in a case of anuria lasting four days, during which the freezing point of the blood remained at the normal figure, viz., 0.56°, Kümmel states to be absolutely at variance with his own experience. He says that although the freezing point, in such instances, was found by him to be normal at the beginning of the attack, it invariably rose more and more—to 0.6° and more—until death occurred.

The above quotations from Kümmel refer to the sum total of the kidney function and not to unilateral renal disease.

Kümmel states that the application of cryoscopy to the mixed urines of the two kidneys has no value. Furthermore, the freezing point of the blood may be normal or within the limits indicating a normal renal function—0.57° to 0.55°—and yet one kidney may be diseased. This he has found to be true in a series of cases of pyelitis, pyonephrosis, tuberculosis, hydronephrosis, and renal tumor of one kidney only.

In order to determine the function of each kidney separately, the urine must be drawn from each of them by ureteral catheters. The examination thereafter, when disease is present in one of the organs, reveals its existence by the diminished secretion of urea and the variation in the freezing point of the urine of the diseased kidney, and by a normal condition of that coming from the other one. The same facts will be noticed in the presence of pus, blood, etc., in the specimen from the diseased side. The molecular concentration of the blood, as shown by the freezing point, may very likely be normal under such conditions.

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2. Watson. Boston Medical and Surgical Journal, December 4, 1902, p. 609.

CHAPTER XIX.

URETHRAL SHOCK OR CHILL—URINARY INFECTION OR URINARY FEVER.

Definition and Etiology.—*Urethral shock* or *chill*, *urethral fever*, *catheter fever*, *urinary infection*, or *septicemia*, and *urinary fever* are terms often indiscriminately employed to designate certain conditions characterized by symptoms which are more or less similar in many respects, and which proceed from the same exciting causes, namely, one or another kind of surgical intervention or manipulation, or trauma, applied to some part of the genito-urinary tract—in the case of the first two named, strictly speaking—to the urethra only.

As a matter of fact, there are two distinct conditions to be recognized, one of them being primarily and essentially of a reflex nervous nature, with or without some degree of septic infection superadded, while the other is primarily and essentially a septic infection, to which may be added more or less well-marked nervous manifestations, the latter, however, not constituting the essential element of the malady. To the first of them the names urethral shock or chill may be properly applied; to the second, the terms urinary infection or fever are appropriate.

The French school of surgeons, as a rule, maintains that all the cases are of septic origin, and bases this belief largely upon the fact that bacterial absorption has been demonstrated in a certain number of cases in which the symptoms followed promptly upon instrumental manipulation or operations upon the urethra, and which terminated fatally within a very short time; one such case, for example, is reported by Albarran in which death took place within twelve hours and in which large numbers of the Bacillus coli communis were found in the blood and also in the urethra and urine.

This view is not, however, universally shared, and we are of those who hold the opinion that there is a certain proportion of cases which cannot be explained on any other supposition than that they are of reflex nervous origin and nature, this conclusion being based upon the facts that the symptoms in these cases are of purely nervous character and identical with those of shock; that in some instances they occur almost synchronously with the surgical intervention; and that in certain ones which have terminated fatally, no lesion, not even the slightest abrasion, has been present in the entire course of the urethra; and that, conse-

quently, it is improbable, to say the least, that a septic absorption should have occurred of such gravity as to cause the patient's death within a few hours; while, on the other hand, it is perfectly reasonable to assume the occurrence of shock and its consequences to be the cause of the fatal condition.

Much the larger number of the patients doubtless suffer from septic absorption and the symptoms to which it gives rise, rather than from shock, but that there are no cases of shock per se, it is difficult to believe.

Neither the degree of severity of the symptoms, their duration, nor the manner in which they terminate, correspond with the degree of severity of the injury inflicted, the skilful and gentle passage of a sound or small bougie being more frequently followed by the manifestations of urethral shock than when a more or less extensive traumatism is inflicted. A striking example of this fact is often furnished by some patients who, having had the symptoms of urethral shock or chill after gentle attempts at dilating strictures, do not exhibit them at all after the performance of a free internal or external urethrotomy. And, again, there is a conspicuous, though by no means invariable, absence of evidence of urethral shock in many cases of extensive injury of the urethra, of which false passage made instrumentally is a common example.

There is a distinctly greater tendency to the occurrence of the nervous phenomena if instrumental manipulation or injury are applied to the deeper parts of the urethral canal than when they are confined to the anterior part of it. The greater richness of the nerve supply in the former situation as compared to the latter may explain this.

In case of *urinary infection or fever* the source of the septic invasion is the bacteria-laden urine or septic products retained within some part of the urinary tract, or both agents may be etiologically active. The contact of these fluids with urethral abrasions, or wounds, or preceding lesions of some part of the genito-urinary tract, especially when such contact is prolonged by conditions which favor their retention, invites septic absorption and produces the symptoms which characterize it.

Such conditions, therefore, are predisposing causes to urinary fever. Among the most frequent of them are pyelitis, pyonephrosis, and prostatic hypertrophy with its immediate results, viz., decomposing residual urine and purulent cystitis.

Classification.—The cases of both urethral shock and of urinary fever present considerable variations, and, corresponding to these differences, it is customary to separate them into special classes, thus:

Urinary Shock or Chill:

1. *Mild shock.*
2. *Severe shock.*

And, again, according to the part of the organism upon which the force of the attack chiefly falls, they are grouped as:

3. *Shock to the kidneys, producing urinary suppression and uremia.*
4. *Shock involving the whole nervous system.*

In the cases of *urinary infection*, the following classification is generally made:

1. *Acute transitory urinary fever.*
2. *Acute recurrent urinary fever.*
3. *Chronic urinary fever.*

Each of these special groups is generally stated to present certain definite symptoms, which we shall now consider, with the prefatory statement that the subdivision is an arbitrary one, and that it is often difficult or impossible to definitely discriminate at the bedside one of these classes from another; and, furthermore, it is sometimes impossible to assert whether or not a given case belongs to the septic or to the purely nervous class.

Symptoms.—URETHRAL SHOCK OR CHILL.—*Mild Shock.*—The larger number of cases fall under this head. As a rule, the nervous phenomena follow upon the first passage of an instrument into or through the urethra of an individual of a highly sensitive nervous system, but they may appear at any one of a number of subsequent examinations of the sort, or following urethral operations. Sometimes they are seen for the first time upon the passage of an instrument after an internal urethrotomy, and, again, the first manifestation occurs after a certain degree of expansion of the urethra has been reached in the course of the treatment of stricture by gradual dilatation.

The signs of shock are one or more of the following: sense of faintness, pallor, a tendency to sighing respiration, moderate sweating, more or less nausea, sometimes vomiting, and a sense of bodily weakness. Occasionally there is complete loss of consciousness, lasting for a short time, and a moderate chill is frequent. These symptoms are usually of short duration and not very severe in character. If they persist, are repeated, or become of greater severity the case passes into the group of those called severe shock. It is noticeable that the symptoms may appear when the examination has caused no pain.

Severe Shock.—Now and then there occurs a case in which the passage of an instrument through the urethra is followed immediately, or very shortly, by a more severe grade of the same train of symptoms as those just mentioned, and may result fatally. Fortunately, this is of rare occurrence. The writer has had one such experience. In this case, the patient fainted immediately upon the withdrawal of a sound which had been gently passed into the bladder. There was much difficulty in

resuscitating him. The periods of collapse were repeated at short intervals during the next three or four hours, at the end of which he died. Thompson records two such deaths, which occurred within forty-eight hours after the passage of a soft-rubber catheter through narrow strictures. Harrison, Banks, Lister, Velpeau, Freyer, and Fordyce are among those who have recorded similar experiences.

In some of the fatal cases autopsy has shown that the kidneys were to a greater or less degree damaged, but this is by no means invariably the case. The existence of an acute renal congestion is especially characteristic, and may not be associated with any actual lesion of the kidneys of prior standing. In true urinary fever, with but few exceptions, a renal lesion of greater or less degree is present.

The patient may die in the first attack of shock; more frequently there are several successive recurrences, marked by chills, convulsions, loss of consciousness, and great depression.

The fever and sweats, which, in the milder forms of the condition, usually succeed the rigor, are often absent or but slightly marked. The skin is cold and dry, and pallor is conspicuous. The temperature is subnormal, pulse rapid, weak, and irregular. The urinary function of the kidneys is suppressed.

URINARY FEVER OR INFECTION.—Guyon, Thompson, and other writers describe two forms of this malady—the *acute* and the *chronic*. A still further division is made of the *acute form* into (1) *acute transitory*, and (2) *acute recurrent*. The former is characterized by the occurrence of a single chill, with succeeding fever and sweat, the latter by repetitions of these phenomena, and is of a more serious character.

1. ACUTE TRANSITORY URINARY FEVER OR INFECTION.—*Symptoms*.—In the smaller number of cases the attack begins shortly after the instrumental manipulation or surgical operation; as a rule, the symptoms are not manifested sooner than the first twelve to twenty-four hours. The first act of urination after an operation upon the urethra is a frequent signal for the beginning of the symptoms. It is immediately or very soon followed by a more or less well-marked rigor, which is succeeded by a rise of temperature. The latter ordinarily does not reach a higher point than 103°, but it sometimes goes as high as 105° or even 106° F.

The fever usually lasts about four or five hours, and defervescence is accompanied by profuse sweating, the latter being followed by a period of exhaustion, after which the patient's strength begins to be restored, and his recovery is generally rapid.

The chill in these cases is not repeated.

2. ACUTE RECURRENT URINARY FEVER OR INFECTION.—This is the more severe form of the malady and differs from that just described in that

there is a recurrence of the paroxysms, a longer persistence of them, and greater bodily prostration results.

The tongue, which is at first bright red, becomes later heavily coated, brown, cracked, and dry. Thirst is distressing, the appetite is lost, and in some instances diarrhœa and vomiting are present, and occasionally closely simulate these symptoms as they appear in cases of cholera.

In a certain number of the cases the recurring paroxysms exhibit a periodicity suggestive of malaria, and are often erroneously attributed to that disease.

When recovery takes place, the course of the malady is ordinarily about a fortnight in duration. When the termination is fatal, as it frequently is, especially in aged subjects, the fever does not show remissions, but is almost constantly high until just before death, when the temperature becomes subnormal and so remains until the end.

It is well to note the fact that even the frequent recurrence of very high temperature is not necessarily a fatal sign. In one of the writer's cases, in which an internal urethrotomy had been done, the first urination and every subsequent passage of instruments into the urethra during the next three weeks was followed by a rise of temperature to 106° F. The patient not only recovered, but did not *appear* to be seriously ill even at the height of the paroxysms of the fever.

3. CHRONIC URINARY FEVER.—The typical picture presented by the patient suffering from this form of urinary fever is that so often seen in cases of hypertrophy of the prostate, when the patient has reached the point at which he begins to run down hill. At this time the symptoms which appear are as follows: A gradual loss of appetite, strength, flesh; sometimes more or less mental confusion; the tongue is coated and dry; thirst is pronounced. There is apt to be a mingling of the symptoms of a low form of uremia with the septic condition. The well-marked chills of the acute form are absent. Instead, there occurs a rather indefinite chilly sensation. A moderate degree of fever exists.

In the more severe forms, the temperature may be considerably elevated; there is an absence of the marked remissions which characterize the recurrent variety of the acute malady. The temperature presents the daily variations which are seen in cases of general systemic septicemia.

The urine is purulent, and is (during the earlier part of the malady, at any rate) often large in amount and contains a diminished quantity of solids. In the cases terminating fatally, the quantity diminishes toward the end of the disease, and the urinary function of the kidneys finally becomes suppressed.

Diagnosis.—The essential points to be noted in connection with the diagnosis of the conditions which have been described above are these: Do not mistake the condition for malaria. Bear in mind that there is one main point of distinction between the two chief groups of the cases, namely, that one of them represents a reflex nervous disorder which is in the nature of shock and its manifestations, the other a septic and toxemic state proceeding from the absorption of toxins or bacteria from the urine or from septic products generated and located in some part of the urinary tract. The distinctive features of the former of these two conditions are the phenomena of a nervous character and the absence of fever in many instances; their appearance in immediate connection or very shortly after surgical intervention or instrumental manipulation in the urethra, and, in the milder cases, their transitory and moderate character.

In the septic cases the inception of the symptoms is, as a rule (though not invariably), more tardy; the fever, the purulent character of the urine, the fact that there is in the cases in which it is present some malady of the urinary tract which allows the partial retention of urine and its decomposition; the evidences of such conditions furnished by the urine, all aid to discriminate urinary fever of septic origin from either malaria or the reflex nervous urethral shock which we discussed as the first of the conditions in this section.

Prognosis.—URETHRAL SHOCK.—But few patients die of urethral shock. Alarming symptoms, even, are not very common, yet a number of surgeons of skill and large experience have had the misfortune to lose one or two patients. It is impossible to predict or to guard against the mishap; it is unusual to be able to avert the fatal termination in the very serious cases by any form of treatment. In the great majority of instances the symptoms are of short duration, even when of severe character, and the patients respond to the ordinary treatment of shock by stimulants, heat, shock enemas in the rectum, and elevation of the feet. The prognosis is much graver in the cases in which there is a suspension of the urinary function.

The prognosis of *acute transitory urinary infection* is usually good, especially when the urinary function of the kidneys is not implicated. If the condition becomes chronic, or takes on the acute recurrent form, the prognosis is unfavorable, as a rule, though a certain proportion of the patients recover.

In *chronic urinary infection* the prognosis depends chiefly upon the condition of the kidneys and the general physical status of the individual. In cases in which there is obstruction to the free outflow of the urine by the natural channels, and unless the infection, which so generally co-exists

with such partial retention as is commonly present in this variety of the malady, improves under treatment, the prognosis is bad. If the patient's equation of resistance to septic influence is strong, the disease may continue for months before terminating fatally.

Toward the end there is a rapid decline of bodily strength, and the patient soon dies, often presenting marked uremic symptoms. The intelligence is clouded, hiccough and diarrhœa are prominent symptoms, the temperature often becomes subnormal, and so remains until the end.

Treatment.—PROPHYLACTIC.—Little can be done to avert urethral shock, and there is no way of anticipating its occurrence. Much can be accomplished in the way of averting urinary fever.

The three measures which tend to avert urethral shock or chill are: (1) Warm the instruments that are to be passed into the urethra. (2) Do not pass them into the deep urethra unless it is necessary. (3) Use gentleness, and do not pass the instruments with the patient in an upright position.

The steps to be taken to avoid the occurrence of urinary fever are as follows: Previous to operation administer an intestinal antiseptic drug or one which tends to minimize the activity of the Bacillus communis coli of the intestine, which is the organism that most commonly is present and probably the most frequently active one in cases of infection of the urinary organs and the urine. Betanaphthol and salol are drugs which are commonly employed for this purpose. The irritating effects upon the stomach often produced by the latter medicine should be remembered. A good many patients cannot tolerate it. Calomel in moderate doses is the best intestinal cleanser that can be employed in connection with the above-mentioned remedies.

In addition to these measures, the rectum should be thoroughly cleansed immediately prior to the operation. The most efficient prophylactic, as well as subsequently curative, or at least beneficial, drug in its action upon the urinary tract, and for the purpose of clearing up foul urines, is urotropin, which should be given in doses of from five to seven grains, three times a day, and for several days preceding and following the operation. In some instances it produces more or less irritation of the kidney and bladder. This is the exception, not the rule. When it occurs, the drug should be discontinued for twenty-four hours or so, and it may then be resumed in doses of two or three grains thrice daily, in which quantities it is almost always well borne and may be continued for a long time—several weeks.

When the urine is alkaline from the presence of the alkaline urinary salts, benzonaphthol, in ten-grain doses, thrice daily, is often useful. The drug is split up in the intestine and is absorbed as benzonaphthol

and benzoic acid, and the urine is rendered less alkaline by the influence of these elements, thereby making less active the growth of pathogenic organisms in it. Unless there is an *unrelieved retention* of urine in the bladder, the ingestion of large amounts of water is desirable. Acetate of potash is also helpful in reducing bladder irritability, and, correspondingly, in lessening vesical congestion.

In cases of prostatic hypertrophy, especially when associated with that condition, there is a retention of purulent urine in the kidney, or when the kidneys, as is so frequently the case, are defective in their urinary function, a useful measure is continuous drainage of the bladder with a soft-rubber catheter; or continuous irrigation of the bladder through double soft-rubber catheters after the manner described in the chapter upon the Technique of Operations upon the Prostate.

At the time of the operation one of the most important steps to be taken is the preservation of the bodily warmth. This s accomplished by avoiding, as far as possible, exposure of the patient, by placing long heavy woollen stockings upon the legs, and hot-water bags wherever they can be kept in place about the body.

The bladder should be thoroughly irrigated previous to and at the end of the operation, and should be emptied before the patient is returned to his bed. In all operations upon the urethra this canal should be irrigated at the completion of and also when possible previous to the operation. An excellent drug for this purpose is permanganate of potash in a solution of a strength of 1 part to 4000 of water. Argyrol, in solution of from 2 to 5 per cent., is also excellent.

Aseptic regimen in general should be observed in the performance of the operations, and, what is quite as important, the bladder should be drained for a longer or shorter time following the surgical procedure. (See under the heading of Drainage of the Bladder, chapter on Technique of Operations for Stricture, and also Operations upon the Bladder.)

The diversion of the urinary stream from the freshly cut surfaces made in the urethra by the operation of internal urethrotomy is a valuable prophylactic step for averting urinary fever subsequent to the operation. It may be accomplished in cases in which the incision has been made in the anterior urethra, by the performance of an external perineal urethrotomy and the tying into the bladder through this incision a soft-rubber catheter and retaining it there for the first forty-eight hours, washing out the bladder through it at frequent intervals.

A most important measure to be observed after internal urethrotomy is the institution of urethral irrigations immediately after the first urination following the operation, and also immediately after the first passage of instruments.

The cleansing and drainage of all pouches and dead spaces, such as are often made in the operation of prostatectomy, are important steps to be observed. The removal of the catheter which is draining the bladder is sometimes followed by the symptoms of urethral fever, and in that case the instrument should be replaced.

Treatment during the Attacks.—URETHRAL SHOCK OR CHILL.—The treatment of this condition is that which is usually employed to combat shock. The measures have already been mentioned when speaking of prognosis, to which the reader is referred. In addition to those named, we would mention specifically hot tea and rum, to which lemon juice may be advantageously added. Also, the subcutaneous administration of the usual sterile saline solution, which may be repeated two or three times in the course of twelve hours or so. This is more especially indicated in the cases in which the urinary function is compromised. As a diuretic, cream-of-tartar water is an appropriate remedy. Counter-irritation over the kidneys by means of mustard plasters is also of value. Diffusible stimulants—ammonia—and such cardiac ones as nitroglycerin and digitalis in combination, and, in the cases in which collapse is imminent, strychnine administered subcutaneously, all find a place.

In the cases in which the suspension of the renal function is the chief menace, and in which great cardiac depression does not forbid its employment, we have for a good while held the opinion that it would be not only a justifiable but a desirable procedure to cut down upon one or both of the kidneys in the loin and endeavor to reëstablish the suppressed secretion of urine by incision into the kidney; or, at any rate, by splitting its fibrous capsule.

When urinary suppression is threatened or has occurred, one of the most valuable measures is that of sweating the patient. This may be done either by hot-air baths or by the administration of pilocarpine, or both. Free catharsis is another important measure to be employed. It is best obtained in these cases by the administration of the saline purgatives in whatever doses are found to accomplish the purpose in each individual case. The patient should be urged to drink large quantities of water.

ACUTE URINARY FEVER.—The measures directed to the reëstablishment of the renal function, just mentioned above in connection with the treatment of urethral shock, are equally appropriate in *acute urinary fever*. These and in addition such others as were mentioned in connection with the prophylactic treatment as being beneficial for the purpose of overcoming the septic elements which are the source of danger in this malady, should be applied.

Chronic Urinary Fever.—Besides the measures of bladder drainage by means of the catheter, and of urethral and bladder irrigations which have been spoken of under the head of prophylaxis, there remain the surgical operations, the purpose of which is to remove the obstructions to the free outflow of urine through the natural channels which are constituted by stricture of the urethra and prostatic hypertrophy. Likewise, operations which afford drainage of septic retentions of urine and pus in the kidney, of abscesses about the urethra, in the prostate or elsewhere, in the urinary tract. These measures are fully discussed in the chapters which treat of Stricture, the Prostate, and Suppurative Diseases of the Kidney.

CHAPTER XX.

THE KIDNEYS AND URETERS.

ANATOMY OF THE KIDNEY.

Size, Weight, Form, and Consistency.—The normal kidney is about four and a half inches long, two and a half inches in breadth, and an inch and a half in thickness. It weighs, on an average, from four to five ounces.

In form it resembles the Lima bean. Its outer border is convex, its inner one concave. Its anterior surface is slightly curved forward, its posterior surface is flattened, and sometimes is slightly concave in form.

Upon the anterior surface, near the upper extremity or pole of the right kidney, is a slight depression which corresponds to the area of contact of the organ with the liver, and which is called the hepatic impression. A corresponding depression upon the left kidney marks the area of its contact with the spleen, and is termed the splenic impression.

Brödel's Line.—About one-eighth of an inch *anterior* to the summit of the convex border, and running parallel to it, is often to be seen a slight depression upon the surface of the organ, which has a somewhat lighter color than that of the part immediately about it. This marks the line which corresponds to the most vascular part of the terminal bloodvessel distribution to the kidney, and is called Brödel's line.

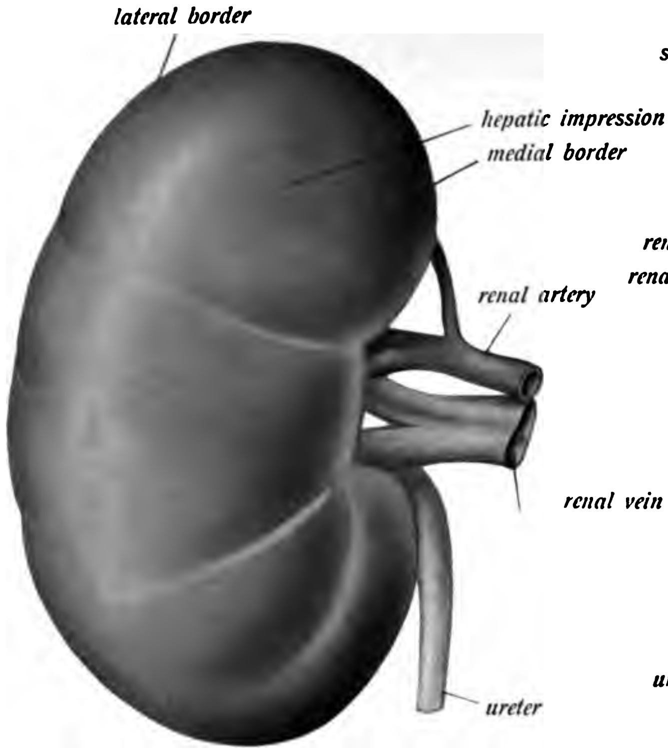
The Hilum.—The hilum is the concave part of the inner border of the kidney which lies between the two extremities of the organ. It forms a fissure or slit-like opening into the kidney, which merges into a chamber called the *sinus of the kidney*.

Plate XXXI shows the characters of the organ just described.

In its consistency the kidney is moderately firm and elastic. This quality is approximately the same throughout the organ under normal conditions. A marked change in it at some one part of the surface as the examining finger is passed over it—such as an area of induration, a depression, or softer spot in the substance—if well-defined, is usually significant of the existence of a pathological process in that place, *e. g.*, an intrarenal tumor, calculus, or distended calyx, and serves to guide the surgeon in locating it.

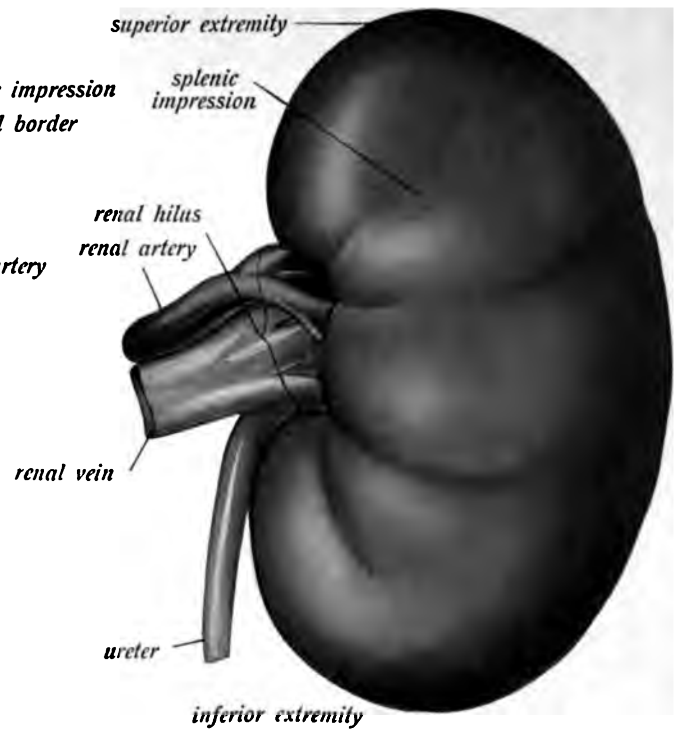
PLATE XXXI

FIG. 1



THE RIGHT KIDNEY SEEN FROM IN FRONT.
(Sobotta.)

FIG. 2



THE LEFT KIDNEY SEEN FROM IN FRONT.
(Sobotta.)

Structure of the Kidney.—On longitudinal section the kidney shows two distinctive parts:

1. **Cortex.**—The cortex, or outer layer of tissue, about one-quarter of an inch in width in its narrower parts, and wider in certain places, which are those at which it extends its area to pass between the Malpighian

Fig. 340

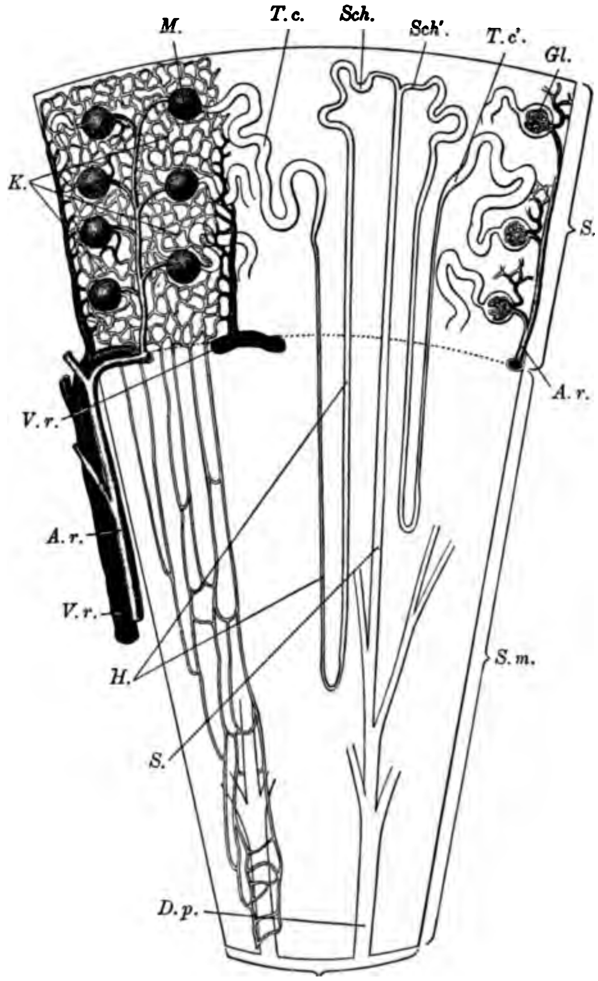


Diagram of structure of kidney in detail: *A.r.*, branch of renal artery; *D.p.*, duct of collecting tubule, Henle's loop; *K.*, capillaries; *M.*, Malpighian body; *S.*, collecting tubule; *Gl.*, glomerulus; *S.c.*, cortex; *S.m.*, medullary substance; *T.c.*, convoluted tubule; *V.r.*, branch of renal vein.

pyramids of the other, or *medullary* tissue. These extensions between the pyramids, called the columns of Bertini, supply a supporting framework and "carry the bloodvessels from the sinus to a line between the cortex and medulla" (Deaver).

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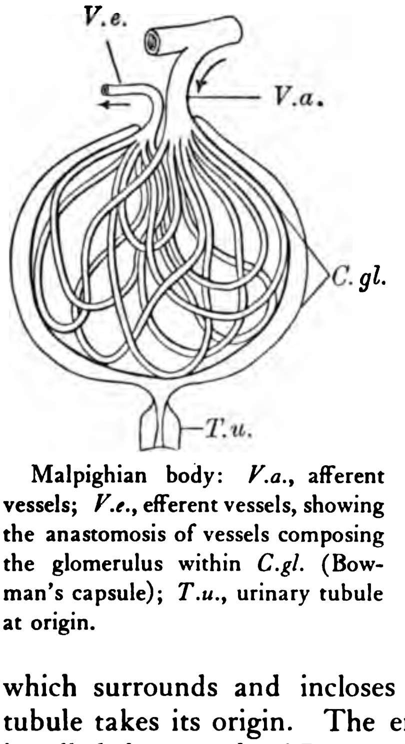
2. **The Medullary Substance.**—The medullary substance contains the lower parts of the loops of Henle and the collecting urinary tubules. The tubules converge as they approach the pelvis and assume the form of pyramids, the bases of which face the exterior part of the organ, while the apices or papillæ point inward and project into the calices, sometimes singly, sometimes two or three to a calyx.

The Calices.—The calices represent the terminal chambers, compartments, or diverticula into which the renal pelvis separates as it extends into the substance of the kidneys; they receive the urinary secretion which is delivered from the individual papillæ which project into them and pass it on into the common triangular-shaped pouch—the renal pelvis—which at its further end delivers the secretion to the ureter.

FIG. 341



Malpighian body: *V.a.*, afferent vessels; *V.e.*, efferent vessels, showing the anastomosis of vessels composing the glomerulus within *C.gl.* (Bowman's capsule); *T.u.*, urinary tubule at origin.

The Cortical Substance.—The external part of the cortex has the appearance of being filled with minute round dots scattered thickly through a paler tissue.

Between the pyramids the cortical projections are marked by slightly converging lines, which are of less definite character, however, than those of the pyramids of the medullary substance. Fig. 341 is a diagrammatic representation of the different minute structures of the cortical and medullary parts of the renal substance (Fig. 341).

The more important part of the parenchyma of the kidney is in the cortex, and the *Malpighian bodies* are its most essential feature. Each of them is composed of an interlacing coil or tuft of afferent and efferent bloodvessels and a capsule which surrounds and incloses them, and from which the uriniferous tubule takes its origin. The envelope inclosing the tuft of bloodvessels is called the *capsule of Bowman* (Fig. 341).

The Renal Tubules.—On issuing from the Malpighian body the tubule has a convoluted form as it descends toward the medullary substance presently changing to a more or less spiral form. Upon nearing the junction of the cortex and the pyramids the tubule becomes straighter and descends well into the pyramid, on reaching a certain point in which it bends upward and returns to the cortex, making in this journey the so-called *loop of Henle*, the first part of which is known as its *descending*

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PLATE XXXII

THE RELATIONS OF RENAL BLOODVESSELS TO THE URETER, CALICES, AND HILUM OF THE KIDNEY. (After Spalteholz.)

limb, and the second part its *ascending limb.* The two parts of the tubule which come before the descending limb of *Henle's loop* is reached are known as the *convoluted* and the *spiral tubules,* respectively. The ascending limb of the loop, on arriving in the cortex, is continued in an irregular convoluted form and leads into still another convoluted canal, which then becomes directly continuous with the beginning of the collecting tubule, which from here descends into the medullary rays in a straight line, becoming enlarged in caliber on its way, and being joined to other collecting tubules which finally terminate upon the surface of the papilla.

Bloodvessels.—The bloodvessels of the kidney are the renal artery, which delivers the blood to it, and the renal vein, which carries it away.

Frequent anomalies of the artery occur, and, in a less degree, of the vein. (See section on Renal Abnormalities.)

From in front backward the vein, the artery, and the ureter stand in the order named.

The Renal Artery.—The renal arteries are given off from the aorta on either side and nearly at right angles to it, and pass *behind* the vein and in *front* of the ureter to the right and left kidney, respectively, the substance of which they enter at the hilum, passing into it along with the calices, and being accompanied by the branches of the renal vein. The artery divides before reaching the border of the hilum into a variable number of branches, one of the main stems of which, in a good many instances, *passes behind the ureter.* (Plate XXXII.)

The majority of kidneys, according to Brödel, are supplied with blood by two sets of vessels which are separated from each other by the renal pelvis as they enter the kidney substance. The more important of these two systems of bloodvessels goes to supply the anterior part of the kidney, while the lesser one is distributed through the posterior portion of it. The two sets of vessels are separated from one another ordinarily by a very slight interval. If the calices and pelvis are distended, this separation may be increased considerably. Brödel's line, already described, marks the line of division between the two sets, anterior and posterior, of the columns of Bertini, which are traversed by and serve as a framework support for the bloodvessels in their course through the kidney. On the other—posterior—side of the convex border, parallel with Brödel's line, and about one centimeter away from it, is the least vascular part of the organ, which is, consequently, that selected for exploratory incision of the kidney.

At the junction of the cortex and the medulla the arterial stems give off anastomosing twigs laterally, which take an arching form and give to this intercommunicating system the name of the *arterial arcade.* From

these arches one set of little branches descends through the pyramids, while another one ascends to the cortex, the latter sending, on their way, minute twigs on either side to the renal substance and extending to the surface of the kidney just beneath the capsule. From this system branches go to and enter the capsules of Bowman, within each of which they are gathered into a ball-like tuft of fine arterioles, the entering branches of which belong to the afferent, and their continuations, which leave the capsule, to the efferent arteries, and which together complete the vascular tuft within the capsular envelope. The latter is known as the *glomerulus*.

The afferent artery enters and the efferent artery departs by a single stem (see Fig. 341). After leaving the capsule the efferent artery goes to the convoluted tubules, around which it breaks up into a capillary network, which joins a corresponding system of capillary veins. The latter proceed, in successively larger venous channels, which accompany the arterial branches, and ultimately unite to form the renal vein which returns the blood to the general circulation after its journey through the kidney, just described.

FIG. 342

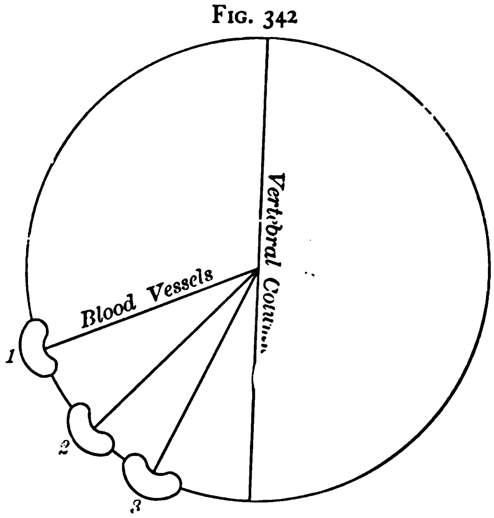


Diagram illustrating the direction given to the kidney by the renal bloodvessels in the descent of the organ when it is abnormally mobile.

Other terminal arterioles penetrate and pass through the renal capsule, supplying it, in part at any rate, and forming a capillary system which communicates with the capillary system in the perirenal adipose tissue, according to Steinach.[1]

Just what and just how important a role may be assumed by this last-mentioned capillary anastomosis in establishing a useful and supplementary circulation of the kidney under certain diseased conditions of the organ is very uncertain, but it is reasonable to suppose that it may assume more or less importance under such circumstances.

The right renal artery is longer than the left one, while the right renal vein is shorter than its fellow of the other side. The relative shortness of the right renal vein is of practical importance, since it makes it difficult to bring the kidney out upon the loin with safety, in some instances, when performing the operations of lumbar nephrotomy or nephrectomy. The accidental laceration of this vessel has occurred a number of times,

and is a serious, and may be a fatal, complication in such operations. Arterial branches are—though not invariably—given off to the adrenal gland from the main stem of the renal artery. The spermatic artery is sometimes given off from the same vessel. The spermatic vein joins the renal vein on the left side.

In cases of movable kidney, the downward and outward excursion of the organ is in part limited, and the path taken by the kidney is determined by the renal bloodvessels. These, as the kidney reaches the point at which tension begins to be put upon the bloodvessels, draw the organ inward toward the spine, acting as the arc of a circle (Fig. 342).

Lymphatics.—The lymphatics of the kidneys have an especial importance with respect to the propagation of malignant disease. The comparative infrequency with which carcinoma is propagated by the lymph channels and the variety of the ways in which it does take place in some cases are the notable features in this connection. Israel found entire absence of lymphatic gland infection in 17 out of 43 cases, subsequent to operation; Robertson, 15 lymphatic propagations in 51 cases of cancer of the kidney; Dickinson, 9 in 19 cases; Röhrer, 6 in 115 cases; Guillet, 20 in 70 cases. Added together, and taking the average of glandular propagations, there were 295 cases, 67 of which showed lymphatic glandular propagation, or about 22.6 per cent.

The frequency of lymphatic glandular propagation bears no relation to the size of the tumor.

When lymphatic infection *does* take place, it is usually seen first in the glands about the hilum; in some cases the nodes which extend upward along the vena cava to the mediastinum and those which lie along the iliac vessels in the pelvis are invaded.

The lymphatics are numerous. The fibrous capsule is supplied with a superficial plexus, the deeper set accompanies the bloodvessels from the hilum, both sets go to the lumbar glands; the existence of a communicating lymphatic system between the ureter and the kidney is not clearly established. The bearing and importance of this fact upon the propagation of infections to the kidney from the ureter and bladder are obvious.

Nerves.—The nerves of the kidney are derived from the renal plexus, which is formed from the solar plexus and lesser splanchnic nerve. The nerves accompany the arterial branches. Some pass from the renal plexus to the spermatic plexus and to the ureter.

Renal Epithelium.—The renal tubules and the capsules of Bowman are lined with epithelial cells of forms which vary in different parts of them. The convoluted, spiral, and irregular tubules are, in effect, epithelial secreting glands of peculiar form, and their epithelial cells play a most important part in the organism.

The Coverings of the Kidneys.—Capsula Vera.—The capsula vera is a thin fibrous membrane which invests the surface of the kidney. At the hilum it turns inward, invests the bloodvessels as they enter it, and also becomes continuous with the outer covering of the ureter. It is connected with the external surfaces of the kidney by delicate fibers of connective tissue and by numbers of small bloodvessels.

Under normal conditions the capsule can be easily detached from the kidney as far as its line of entrance into the hilum.

FIG. 343

Transverse section of the body through the kidneys and liver, showing the relation of perirenal fascia and peritoneum to the kidney.

From the outer surface of the capsule connective-tissue fibers are given off and form a network, in the meshes of which lies the perirenal fat, the two together forming the second covering of the kidney—the so-called "fatty capsule." These connective-tissue fibers are inserted at their distal ends into the perirenal fascia, thereby attaching the kidney to the structures which stand in immediate relation with this fascia, in the manner to be described presently. They also pass between the upper end of the kidney and its suprarenal body, thus loosely connecting them.

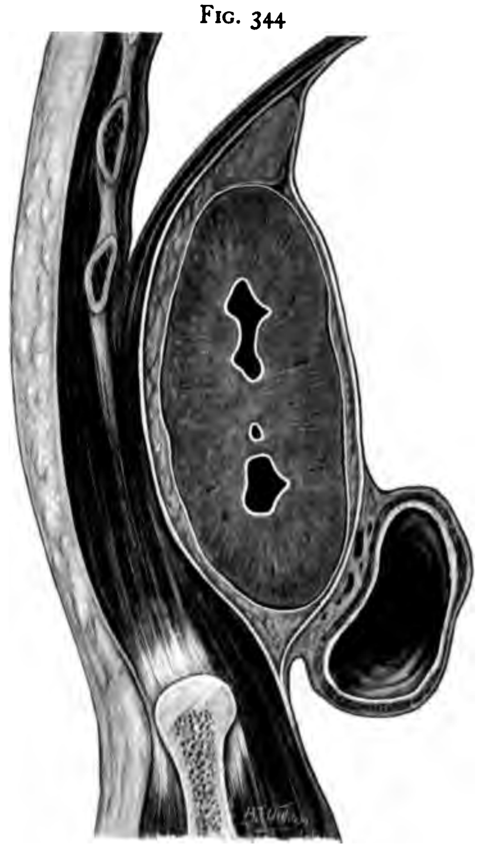
Perirenal Fat Tissue.—The perirenal fat varies in amount in different individuals and at different times in the same individual. It is more abundant over the posterior and outer aspects of the organ than elsewhere, hence the kidney is less closely in contact with the structures lying behind it than with those in front of it.

Perirenal Fascia and the Peritoneum.—The so-called perirenal fascia has been particularly studied by Gerota, Zuckerkandl, Glantenay, Gosset,[2] and some others.

The parietal peritoneum is lined externally or accompanied by a fascia. This fascia exists as a continuous sheet until it reaches the line upon the lateral aspect of the abdominal wall on either side of the body from which the parietal peritoneum is reflected, to pass onto and over the ascending and descending colons, respectively. At this point the accompanying fascia divides into two layers, one of which passes over the front and the other over the back of the kidney of each side. The anterior layer after crossing the kidney in front is continued and joins its fellow of the opposite side, making a continuous membrane overlying the posterior part of the abdominal wall (Fig. 343).

From the point at which it separates from the anterior lamella, the other, or *posterior leaf* of the perirenal fascia, passes *behind* the kidney and is continued across the psoas muscles to be inserted on the lateral aspect of the bodies of the vertebræ near their anterior surface (Fig. 343).

FIG. 344



Profile view of kidney, showing relation of perirenal fascia to the kidney.

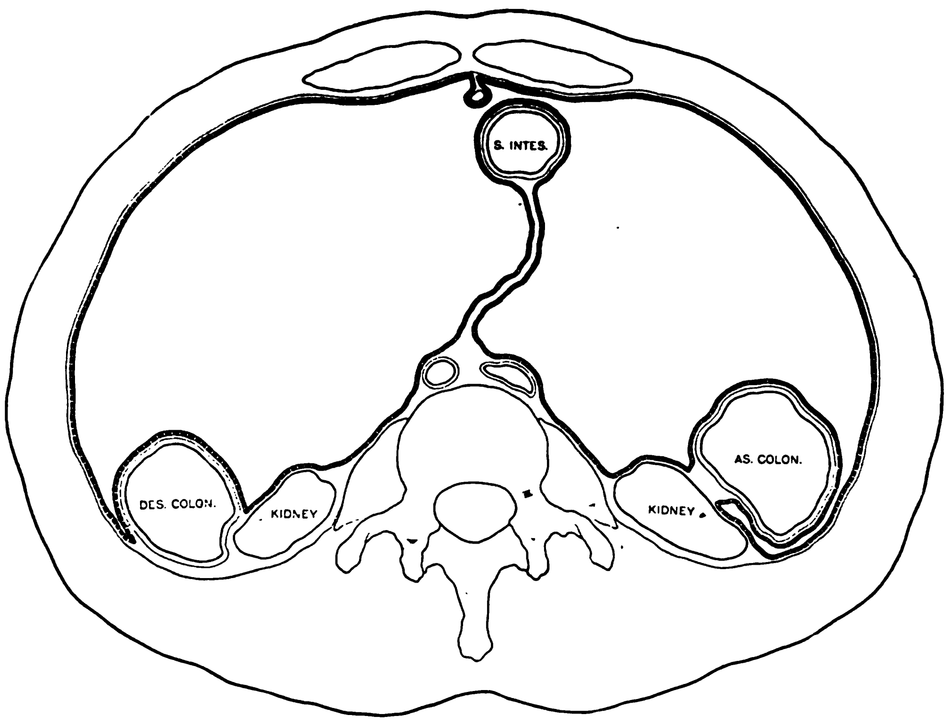
The two lamellæ unite at the upper end of the kidney and send fibers to the under surface of the diaphragm; they also pass between the upper pole of the kidney and the adrenal body, sending fibers to both, thus loosely attaching one to the other. The connection is not an intimate one, and on this account the adrenal remains behind when the kidney is

removed, except when there has been a previous inflammatory process, which has produced adhesions binding them together (see Fig. 344).

Below the kidney the two layers of the perirenal fascia become blended with the lumbar and iliac fascia (see Fig. 344).

In this way there is formed a sac which incloses the kidney and its fatty envelope, and which is closed above and to its outer side, but is more or less open below, and entirely so toward the median line of the body.

Fig. 345



Peritoneum traced below the level of the transverse colon. (Deaver.)

The perirenal fascia is connected by more or less numerous fibers to the peritoneum in front, forming, in fact, if one chooses to so regard it, an inner lining to that membrane in parts of its course, and behind to the lumbar fascia, while from its inner surface numerous fibers pass from both the anterior and posterior lamellæ to the capsula vera, thus uniting the kidney to the inner side of the perirenal fascia. Upon the full development of the number, strength, and normal distribution of the fibers forming this network of connective-tissue attachments the limitation of the movements of the kidney within its normal sphere

largely depends. The other factors concerned in thus restraining it are the bloodvessels passing to the diaphragm; and, secondarily, the firmness of the abdominal walls and the presence of a normal amount of perirenal fat tissue.

Relations of the Peritoneum to the Kidneys.—The parietal peritoneum is reflected from the abdominal wall on either side of the body a little behind the posterior axillary line. From this point it rises and passes onto and over the ascending and descending colons, respectively, on the right and left sides of the body, and is expanded to form the serous investment of the small intestine and other abdominal viscera, as shown diagrammatically in Fig. 345. It is, therefore, a continuous membrane which overlies, but does not, properly speaking, invest the front of the kidney, which, consequently, is an extraperitoneal organ. The portions of the peritoneum which rise to reach the ascending and descending colons after leaving the abdominal parietes, constitute the outer leaf of the respective mesocolons, and as the peritoneum again leaves the bowel on the inner side, after having invested its upper and lateral aspects, it forms their inner leaves. The inner and outer leaves are more or less definitely separated from each other and leave the lower side of the colons devoid of peritoneal investment in consequence. It is this lower portion of the colon on each side that is in contact with the corresponding kidney. It is important to note the fact that in some cases the two layers of the mesocolon are not separated, or but very slightly so. In such instances the accidental tearing of the bloodvessels which pass through the *inner leaf* of the mesocolon is liable to occur when dividing the *outer* one in the transperitoneal exposure of the kidney.

PHYSIOLOGY OF THE KIDNEY.

The kidney is both a secretory and excretory organ. Secretory in that it elaborates and has to do with the production of some part of certain of the urinary constituents, and in all probability is possessed of another functional office, namely, the manufacture of an *internal secretion* the nature of which is as yet unknown. Excretory, in that it is the most important organ in the body which is concerned in the extraction of waste products from the blood and in their elimination from the organism. We may dispose of what little there is to be said with regard to the internal secretion of the kidney in a few words, and will therefore deal with this part of the subject first, in order to clear the ground for the discussion of the better understood urinary function of the kidney.

The Internal Secretion of the Kidney.—Among the things which suggest the probability of the existence of an internal secretion in the elaboration of which the kidney is engaged, may be mentioned the observation that death follows the removal of a considerable portion of the kidneys —an amount which corresponds to approximately three-quarters of their entire weight—although (in somewhat lesser partial removals of the organ) the amounts of water, urea, and urinary salts may actually be increased. That is to say, death would not appear under such circumstances to result from the failure of the remaining renal tissue to eliminate sufficient quantities of the waste products of bodily tissue combustion, and from the consequent poisoning on account of their retention in the circulation, but rather because of the failure of the kidney tissue (owing to the small amount of it present) to produce and return to the organism through the renal vein some substance having the character of an internal secretion which has to do with the maintenance of life and a healthful condition of the individual.

Again, the experiments of Vitzou are of interest in this connection. Vitzou, in a series of experiments, all of which gave similar results, and one of which may, therefore, serve to illustrate all of them, secured the following data:

Two dogs from the renal veins of which a certain amount of blood had been extracted, defibrinated, and preserved in a sterile condition until employed at later periods in the experiment, were sometime subsequent to the removal of this blood submitted to double nephrectomy. One animal was permitted to die in the natural course of the progressive uremia which followed upon the removal of its kidneys. Upon the first appearance of uremic signs in the second animal, an injection of the previously prepared blood of the renal veins was given to it. A prompt cessation of the uremic symptoms resulted from the employment of this injection.

In a less striking manner the same thing resulted with a certain number of subsequent injections. These ultimately failed to arrest the uremic phenomena, and the animal at length died under the influence of the so-called uremic state. Nevertheless, death was delayed for a notable number of hours as compared with the time at which the other dog succumbed.

The dogs which did *not* receive the injections of the renal vein blood lived from sixty-two hours at the shortest to about ninety hours at the longest; those which *had* injections, one hundred and one hours at the shortest to one hundred and sixty-four hours at the longest. Furthermore, it was seen that if the injections were given *before* the appearance of any uremic manifestations their onset was very considerably delayed.

The suggestion here conveyed is that the prolongation of the life of the dog receiving injections was due to the influence of some product contained in the blood of the renal vein, elaborated by the kidney and delivered to the blood after its journey through the organ and on its return to the general circulation; in short, the product of an internal secretion of the organ.

The force of this suggestion might appear to be minimized by the fact that similar, though not such marked, prolongation of life and the mitigation or arrest of uremic symptoms can be procured by the injection of large quantities of the normal physiological saline solution also (Bunjewitsch[3]).

The effects obtained, however, by the saline solution are in all probability due to quite another influence, namely, the dilution of the dose of toxins, the lessening of the molecular density of the blood, and lowering of osmotic pressure, and not to any specific element contained in the fluid injected. The quantities of the renal vein blood employed by Vitzou in his work were too small to have been effective because of dilution of the toxins; consequently, the results of the saline solution experiments do not in any sense contradict the suggestion of the existence of an internal secretion of the kidney conveyed by Vitzou's work, but may even be regarded as strengthening it.

Still another set of experiments—those of Crile and Cole[4]—with blood transfusions made directly from the femoral vein or artery of one living dog into the blood current of another, both of whose kidneys have been removed, are, in a sense, confirmatory of the theory of the existence of an internal secretion of the kidney, and make Vitzou's work even more suggestive of that fact than would have been the case otherwise. Crile concluded as the result of his transfusions that they had no effect in prolonging the life of the animal whose kidneys had been removed, or in averting the uremic condition, which apparently resulted fatally in the same time as it did in the animals with which no transfusions were made. The significant points in connection with Crile's, as compared with Vitzou's experiments, are that the former observer did not give his transfusions at so early a period subsequent to the removal of the animal's kidneys as did the latter, and that the blood employed by Crile was not taken from the renal vein, but from the femoral vessels. The inference, therefore, that the renal vein blood *does* contain a special product, which inhibits in a certain degree uremia, and prolongs life when it is threatened by the occurrence of the state known as uremia, is strengthened by Crile's results.

The Urinary Function of the Kidney.—In its performance of the urinary function, the kidney serves in a double capacity: (1) As a filter

through which the watery and solid constituents of the urine are passed from the blood, under the influence of the laws governing osmotic phenomena; and (2) in some measure, at any rate, as a secreting organ, by virtue of whose capacity in this respect certain of the urinary constituents are elaborated or modified.

The first of these factors is represented, anatomically, by the walls of the bloodvessels of the glomeruli and of some of the urinary tubules; the second of them by the epithelial cells of the renal convoluted tubules.

The collecting tubules have the function chiefly of ducts, and conduct the urine to its point of egress from the substance of the kidney, viz., the papilla.

The belief that the kidney performs the function of a gland in the sense that it is capable of elaborating, by virtue of the activity of some of its epithelial cells, substances delivered to it by the blood or of modifying their character in certain respects, is based, in part, upon the knowledge that hippuric acid is formed in the kidney at the expense of benzoic acid and glycocol. Theoretically, the value and amount of glandular activity taking place in the kidney at any time, might be determined by estimating the amount of hippuric acid eliminated, but practically the process is too complicated to be employed clinically. In part, the evidence of renal glandular activity rests upon the change in the drug phloridzin which takes place, it is believed, by the action exercised upon it by the tubular epithelium, and as a result of which glucose is separated out from it, and appears in the urine as such. Doubt is cast upon the latter proof of the secretory capabilities of the renal epithelial cells by an experiment of Domenici, in which he found glucose to be present in the blood of dogs after having given them injections of phloridzin and after both kidneys had been removed from the animals. On the other hand, the great diminution or entire failure of glucose elimination which frequently takes place when the kidneys are seriously diseased, appears to indicate the importance of the kidney in effecting the separation of sugar from phloridzin, which, as has been said, occurs when the kidneys are *not* diseased.

Our present knowledge with regard to any specific secretory activity resident in the renal epithelial cells or in any part of the organ is very limited, and we are not in a position to assert anything positive about it.

That the role of the Malpighian bodies with relation to the production of the urine is an important one is shown by the fact that in the diseases of the kidney in which there is a marked defect in the elimination of both solid and watery constituents, the lesions are found to have their seat more especially in those bodies.

Urea is not *secreted* by the kidney at all, but is excreted by the epithelial cells of the tubules and of the Malpighian bodies as well. Urea exists normally in the blood and is normally excreted by the kidney, and is believed to represent the final step of the combustion of tissue proteids and of food albuminoids ingested.

It is important to remember, in estimating the value of the amounts of urea present in the urine, that these are decidedly affected by the quantities of albuminoids ingested with the food; similarly, it is of importance to know the amount of fluid ingested, whether the individual has been sweating profusely or not, whether he is suffering from profuse diarrhœa at the time, and if any nervous influence likely to affect the urinary excretion has been operative, when we are judging of the importance and significance of the quantities of urine passed.

In its totality of excretory activity the kidney performs, when acting normally, the office of maintaining the balance of the molecular concentration of the blood and of the urine at the points which represent the condition in this respect of these fluids which is essential to the maintenance of good health. Whether or not this total diuresis is being properly carried out is determined by what is known as the cryoscopic test of the blood and of the urine (See chapter on Urinary Analysis.)

In its function as a filter the kidney's capability depends upon a normal condition of the membranes in the organ which are interposed between the blood and the urine, upon the force and rapidity of the blood current, and upon the influence of certain nervous conditions which are not at all understood.

ABNORMALITIES OF THE KIDNEY, ITS BLOODVESSELS AND URETERS.

Frequency.—Keyes[5] tabulates the cases of abnormality of the kidneys which are mentioned in Morris' work[6] with reference to the relative frequency with which the different forms of them occur, as follows:

	Cases.
Horseshoe kidney	16
Congenital (unilateral) atrophy	11
Misplaced kidneys	10
Lobulated kidney (4 bilateral)	9
Malformed kidneys (1 bilateral)	6
Fused kidney	1
	53

These cases occurred in the course of 11,168 postmortem examinations, or in proportion of about 1 in 211.

An article written by Brewer[7] gives an impression of a far greater proportion of abnormal conditions and of the frequency with which one or another sort of abnormality of the kidney, its bloodvessels, or ureter occurs. The following data are taken from this publication:

"The total number of postmortem examinations made was 151. In this number there were found the following irregularities:

"*Arteries.*—Eighty-five had more than a single trunk, or about 56 per cent.; in 70 cases there were two arterial trunks; in 12 cases there were three arterial trunks; in 2 cases there were four arterial trunks; and in 1 case there were five arterial trunks.

"In the case in which there were five trunks, they were derived as follows: 3 from the aorta, 1 from the ovarian, and 1 from the common iliac arteries.

"Twenty-eight kidneys received arterial trunks in other locations than the hilum, as follows: 19, a large trunk or branch at the upper pole; 6, a large trunk or branch at the lower pole; 3, a large trunk or branch on the anterior surfaces.

"Any of these branches might easily have been injured in the performance of nephrectomy or nephrotomy.

"The spermatic artery in one case was given off from the renal, and unquestionably would have been included in the ligature of the renal pedicle in the performance of nephrectomy. In two other cases the spermatic artery arose from the aorta above the renal, crossed the pedicle near its middle, and probably would have been included in such a ligature. In one case, two large renal arteries arose from a common trunk with the suprarenal and phrenic arteries. In one case, a large venous trunk from the left kidney passed *under* the aorta to the inferior vena cava.

"*Ureter.*—In one case, two ureters from each kidney; the two from the right one united near the bladder, while the two from the left one entered the bladder separately.

"In one case, two complete ureters, the one from the upper portion of the hilum being markedly diseased, as was the pelvis of the organ, while the one from the lower segment of the kidney was perfectly healthy.

"In two other cases there were double ureters above, which united to form a common trunk below.

"*Displacements of the Kidneys.*—Of the 151 subjects, there were 14, or 9.2 per cent., whose kidneys were found to be displaced. Of these, 10 were males and 4 females. Of the 10 displacements occurring in males, 6 were on the right side and 4 on the left side."

Abnormalities of the kidneys are usually classified under the three headings:

1. Abnormalities of position.
2. Abnormalities of form.
3. Abnormalities of number.

1. **Abnormalities of Position.**—Temporary and variable changes of position, such as may be assumed by movable kidneys, are not properly included under the heading Misplaced Kidneys. The term is intended to designate only the congenital misplacements of the organ, which are permanent.

In but one instance with which we are familiar are both kidneys reported to have been misplaced. This one is recorded by Potherat.[8] In this case the two organs lay upon the brim of the pelvis.

Frequency.—Morris[6] gives the following figures with reference to the frequency with which the kidneys are found to be misplaced:

	Postmortems.	Misplaced kidneys.
Middlesex Hospital	6,536	4
Guy's Hospital	4,632	7
	11,168	11

The misplaced kidney may occupy any position between its normal one and the lower part of the pelvis.

In some locations the abnormality may be a source of danger in parturition, and it may also cause difficulty in making the diagnosis in cases of supposed intra-abdominal tumor.

This congenital abnormality of the kidney is apt to be associated with other abnormal conditions of the organ, its bloodvessels, or ureter, and sometimes with unusual conditions of other organs. Thus, changes in the form of the misplaced organ—lobulation or asymmetry—are reported.

The suprarenal body is often left in its usual position, not being misplaced together with the kidney.

Acquired Displacements.—These are either the so-called movable kidneys, or those which, having been movable, become attached in abnormal places by inflammatory changes in the perirenal tissue. The latter condition has a practical importance, and it may be one that involves serious danger to the individual. These forms of displacement are further discussed in the chapter on Movable Kidney.

2. **Abnormalities of Form.**—Certain of the malformations of the kidney are of great practical importance, since the failure to recognize them at the time of an operation may cause serious consequences, and because of the difficulty which may arise in the diagnosis.

Varieties of Malformations.—These are classified by Morris as follows:

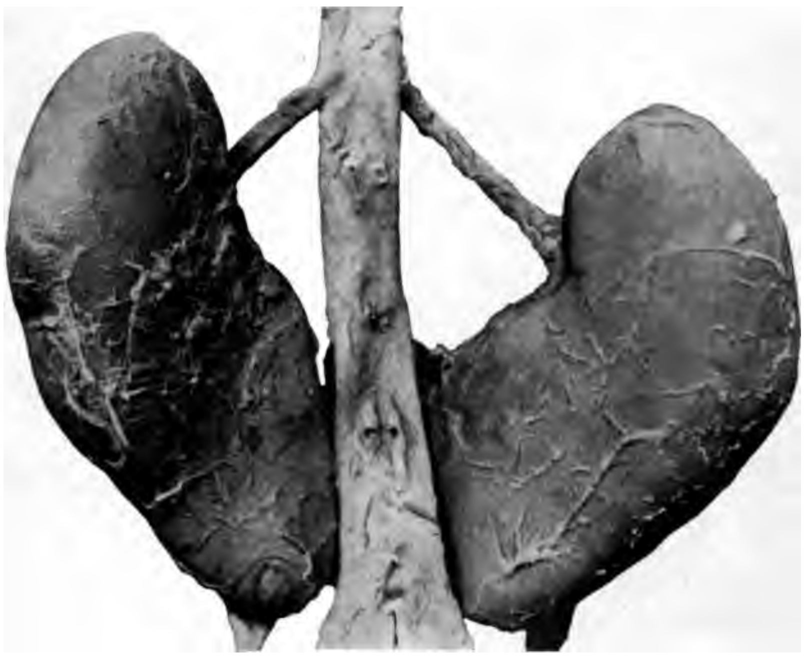
a. Variations in size.

b. Malformation of one or both kidneys without any junction or fusion of the organs.

c. Fusion of the two kidneys, either in the form of a "horseshoe" kidney or some other irregular-shaped mass.

(*a*) The most important of this class of malformations is congenital atrophy, because of its frequency as compared with any other of these deformities, and owing to the failure of functional activity and efficiency involved in the condition, which may make nephrectomy impossible.

FIG. 346



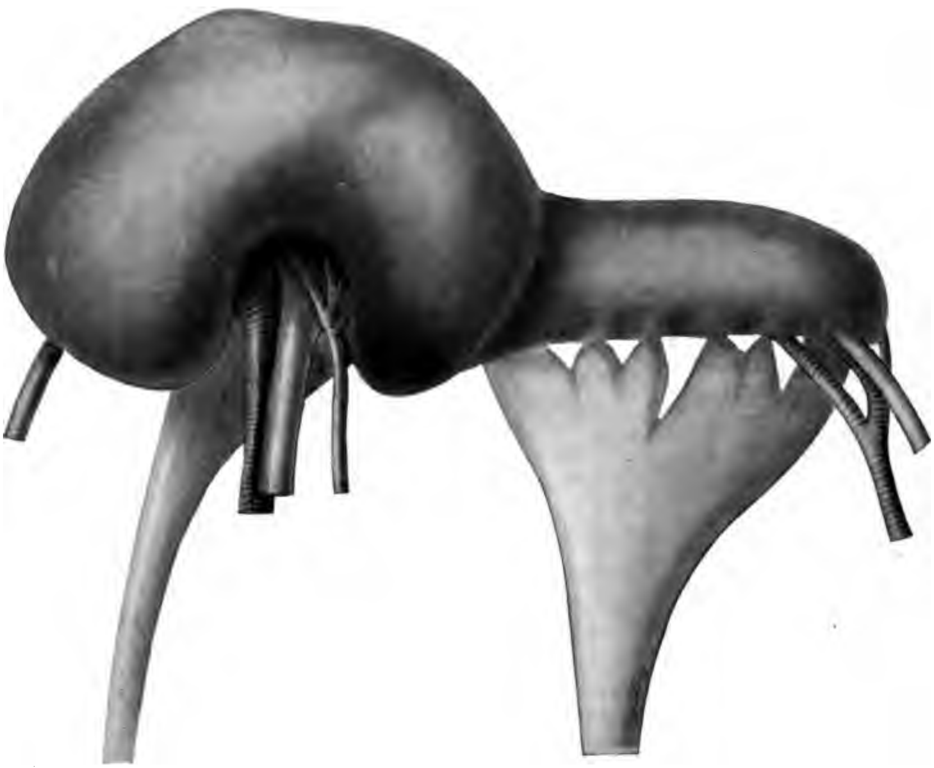
Horseshoe kidney.

(*b*) Of this class, the lobulated kidney is the most frequent example. It has but little clinical importance in some instances, while in others the contrary is the case. Associated abnormalities of the bloodvessels are the most essential thing to remember in connection with this sort of malformation, for they are common, and, when present, may be a source of danger when nephrotomy, nephrolithotomy, or nephrectomy are performed. The existence of such a kidney should, therefore, put the surgeon on his guard with respect to an abnormal distribution of the bloodvessels.

The writer has seen aberrant arteries traversing the surface of the organ and occupying furrows between the lobulations of such kidneys, accidentally wounded when the convex border was incised in the performance of nephrotomy.

Lobulated kidneys sometimes have striking and unusual changes of form. An example of such change is referred to by Morris, in which the kidney was trilobate in shape and was supplied by three arteries derived from different parts of the aorta. Its hilum was in front, and the ureter came off from its anterior surface. Its posterior surface was marked by a sulcus, in which the common iliac artery rested.

FIG. 347



Fused kidney and irregular distribution of renal bloodvessels and abnormal renal pelvis.

(*c*) The common example of this variety of malformation is the "horseshoe" kidney. In this condition (Fig. 346) the two kidneys are joined into one mass, which sometimes lies transversely across the course of the vertebral column and sometimes has a more or less irregular shape and is placed more laterally. An odd instance of the joining of the two organs is that seen in Fig. 347, which is taken from a specimen in the writer's possession. In this instance the left kidney was atrophied,

lay transversely across the vertebral column, and was joined by its right pole to the left one of the right kidney, which lay in a similar position with reference to the spine. The right kidney was somewhat smaller than usual, and its tissue was apparently normal. The substance of the left part of the mass showed but slight structural variation from the normal condition. The left kidney was furnished with a curious and rare malformation of the renal pelvis, which was divided as it left the hilum into six separate and distinct branches, which united as the pelvis advanced, first into three compartments and then into a single one, which was much longer than the renal pelvis should be, and which eventually became continuous with the single canal of an ordinarily formed ureter. The ureter and pelvis of the other side of the mass showed no unusual feature. The blood supply of the small left kidney was derived from a small artery which as well as the vein entered the organ at its left extremity, the artery dividing into three separate branches previous to so doing. The right part of the mass was supplied with a normal renal artery and vein, but had, in addition, two other smaller arterial branches, both derived from the aorta, one of which entered the organ upon the anterior aspect of the hilum and the other at the right extremity of the kidney.

Fused kidneys are always more or less displaced from the normal position of the organ. They are also frequently associated with irregularities of the bloodvessels supplying them.

3. **Abnormalities of Number.**—This group of malformations is divided by Morris into special classes, as follows:

a. Single, or unsymmetrical kidney, where one is entirely absent.

b. Solitary, or fused kidney, where the two kidneys are massed together.

c. Imperfect development or atrophy of one kidney.

d. Absence of both kidneys.

e. Supernumerary kidneys.

Of the above, the absence of one kidney is the most serious condition from the practical point of view.

Single Kidney.—The condition in which there is a congenital absence of one kidney.

Frequency.—Various estimates of the frequency of occurrence of the absence or extreme atrophy of one kidney are given by Morris, from which—averaging the whole number of the cases derived from different sources—it appears that absence of one of the kidneys occurs in 1 in 2400 individuals.

Ballowitz,[9] in 1895, collected 210 cases of congenital absence of one kidney. Almost without exception, the single kidney present was of

normal shape and consistency, and showed compensatory hypertrophy. On the other hand, cases have been reported in which no such enlargement was present. The ureter and its vesical orifice are absent or defective in most cases. In a few instances, the ureteral orifice has been present and the canal of the duct could be traced for from 1 to 2 cm. Above this point the ureter was obliterated. The ureteral vesical orifice of the existing kidney is sometimes in an abnormal position. The adrenal body is, as a rule, absent, and so, too, are the renal bloodvessels.

In the only instance in which the writer has met with this condition, there was no trace of the left kidney whatever. And the same was true of the renal bloodvessels, ureter, and its vesical orifice. The adrenal gland, however, was present. The single ureteral orifice of the other kidney entered the bladder in a perfectly normal manner at its usual place.

In this instance, owing to an unfortunate cystoscopic error, the only kidney was removed. It was the seat of cancerous disease. The patient lived eight days and had no uremic manifestations until the sixth day. Frisch and Zuckerkandl refer to seven other cases in which the same misfortune occurred to other surgeons.

Position.—The single kidney in the cases of congenital absence of its fellow organ sometimes occupies an abnormal position, but frequently this is not found to be so.

The renal bloodvessels of the single kidney are stated by Morris to be increased in number, or size, or in both, in some instances, and if the kidney is misplaced, the arteries supplying it are commonly derived from the iliac or middle sacral artery. The bloodvessels on the side of the absent kidney are either rudimentary or lacking.

Associated Abnormalities.—Morris refers to the number of associated congenital abnormalities found in the series of 226 cases of single kidney collected by Ballowitz, which he states to have been 33 per cent. These defects were of the genital organs. In the males there was absence of the vas deferens, vesicula seminalis, and ejaculatory duct on the same side in greater frequency than any other abnormality. Complete absence of the testis of the same side has also been observed.

In the female, bifid uterus, duplication of the vagina, unicorn uterus, absence of the Fallopian tube, and absence of the ovary have all been reported.

Fused Kidney.—The horseshoe kidney has already been referred to. In addition to this more common of the varieties of fusion of the two organs, there are a number of other conditions which are of interest. Among them the following are described by Morris.[6]

Both kidneys fused together, and lying upon the left side of the body, the left one being in its normal position. The right kidney lay immediately below it, and was fused into one S-shaped mass by the junction of the upper and lower ends, respectively, of the two kidneys. Each part of this mass was provided with a separate ureter. The left one followed the usual course of the left ureter. That one which belonged to the part of the mass which represented the transposed right kidney crossed over to the right side of the vertebral column and entered the bladder in the normal position of the right ureter.

The renal vein supplying the lower half of the fused body passed in front of the aorta to the hilum of this portion of it. The arterial supply was by two branches, one arising from the aorta a little over an inch above its bifurcation and entering the convex border of the lower part of the renal mass, the other coming from the left common iliac artery and entering the lower pole of the right kidney. In another case, reported by G. Tully Vaughan,[10] the single mass was grooved in such a way as to suggest its division into five lobules. Still another example, quoted by Morris, is the case of Botallus. In this there were four bodies, each apparently representing a kidney, and all of them being fused into a single mass.

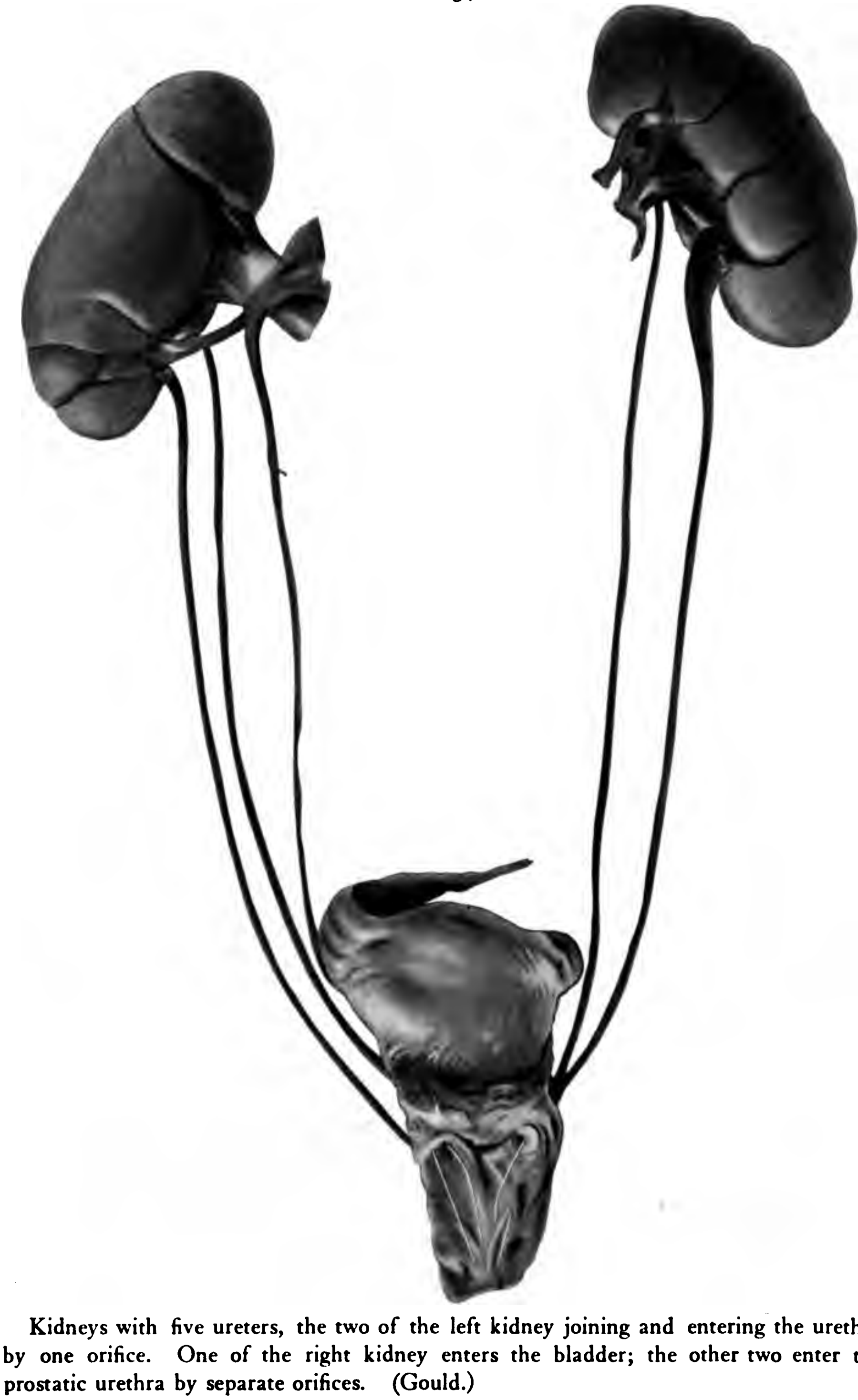
Supernumerary Kidneys.—This condition is rare. Morris[11] refers to three cases. In one, a third and very small kidney occupied the hilum of the left kidney and was supplied by a short ureter which ran into the ureter of the left kidney. The *second case* was recorded by Newman. In this the third kidney was represented by a small pear-shaped body near the upper margin of the left kidney. It had a distinct ureter, which entered the ureter of the left kidney about half an inch below its pelvis. The third case is reported by Watson Cheyne.[12] In this case the supernumerary gland was discovered during laparotomy. It was well-developed, and situated on the right side of the lower part of the spinal column just at the brim of the pelvis, and was three or four inches below the right kidney. It had its own ureter and blood supply. The third kidney was freely movable.

ABNORMALITIES OF THE URETER.

Abnormalities of the ureter are as follows: absence, duplication, fusion, valves, abnormal terminations.

Absence of one ureter is seen almost invariably in cases in which one kidney is absent; in a few instances reported there has been a rudimentary lower end of the ureter on the same side as that on which the kidney is absent, and it has then appeared as a cord without any canal

FIG. 348



Kidneys with five ureters, the two of the left kidney joining and entering the urethra by one orifice. One of the right kidney enters the bladder; the other two enter the prostatic urethra by separate orifices. (Gould.)

or properly formed vesical orifice. Moullin[13] records the case of a girl, aged fourteen years, who had neither kidneys nor ureters. In cases of congenital atrophy of the kidney, the ureter has usually been found to be abnormal in one way or another, *e. g.*, its canal is obliterated; it lacks any connection with the bladder, or else the communication with the bladder is abnormally small.

Ureteral defects are usually associated with abnormalities of the kidneys. They are more frequently unilateral than bilateral.

Duplication.—The ureters may be duplicated on one or both sides; they may be duplicated in part of their course and unite into one channel for the rest of it, or there may be individual ureters throughout their whole lengths. Molinetti[14] recorded the case of an individual with six ureters. In the case illustrated in Fig. 348, which is from a specimen in the Warren Museum of the Harvard Medical School, and reported by Gould,[15] there are three ureters on one side and two on the other.

Fig. 349

Fusion of the ureters near the kidney. (Warren Museum.)

Duplication throughout the whole length of the ureters is more common than through a part of their course.

Lessig[16] estimates the actual frequency of unilateral duplication as from 1 to 4 per cent. Zondek[17] places it at from 3 to 4 per cent.

Robinson,[18] in the course of an article in which a number of anomalies of the ureter are described, mentions a kidney with two pelves and two ureters, and says that in such cases the uppermost of the two ureters habitually crosses behind the lower one, and that its termination in the bladder is farther from the vesical orifice than that of its fellow ureter.

Fusion.—Double or multiple ureters may become united at any point in their course. The union is sometimes seen in connection with the

two ureters of the fused or "horseshoe" kidney. When occurring on one side this condition may acquire serious practical importance, as shown in the interesting case reported by Young, which we have quoted under the heading of Illustrative Cases at the end of the chapter on Renal Calculus.

Fig. 349 illustrates fusion of two ureters close to the kidney.

An important point in connection with abnormalities of the ureters is that they are, in some instances, irregular in their course. In a case reported by Kelly,[19] quoted by Morris, in which there was a blending of the two kidneys into one mass, which lay upon the right side, there were two ureters, the upper one of which was situated anteriorly to the vessels.

According to Morris, it is very rare indeed to have the ureters of a "horseshoe" kidney pass behind the fused renal mass, but he refers to instances which were recorded by Wilks and Moxon, and by Durham, in which they took this course.

Abnormal Terminations of the Ureter.—The ureters may terminate in the urethra, vagina, seminal vesicles, and the rectum. As a rule, this abnormality is associated with other congenital defects. In some instances, however, such is not the case. Chute[20] reports the case of an adult with two ureters on one side, one of which terminated in the prostatic urethra. No other abnormality existed.

Schwarz[21] has recorded 9 cases in which the ureter terminated in the prostatic urethra. In 7 of them there were double ureters. Chute's[20] article includes the reports of three others, besides the one already referred to, in which this condition existed.

Termination of the ureters on the surface of the abdomen below the umbilicus has been reported by Nebel.[22]

In the female the ureters have been reported in 8 cases as terminating in the urethra, in the vagina in 7, in the vulva in 13, and in one instance in a patent Gärtner's duct.

The orifices of the ureters which terminate in abnormal positions are always more or less constricted, and, as a consequence of this fact, the kidneys from which they come are sometimes hydronephrotic. Occasionally, in cases in which the upper end of the ureter is abnormally placed with reference to the kidney, or in which one of two ureters belonging to the same kidney drains but one portion of the organ, the hydronephrosis has been confined to that particular portion of the organ.

Valves.—More or less well-marked valves are found in the upper part of the ureter in a good many cases. Sometimes they are sufficient to seriously obstruct the passage of the catheter through the canal, but

fluids can always be injected through it. In a few cases hydronephrosis is believed to have been referable to such valves.

Symptoms and Diagnosis.—Anomalies of the ureters are not often detected during life. Occasionally the employment of the cystoscope and ureteral catheter will reveal their existence, and, in some instances, the examination of a patient with incontinence of urine may lead to the discovery of an abnormal ureteral termination.

In the case of the abnormally placed ureteral termination in the urethra, the constriction of the orifice, which, as already mentioned, is usually present, may give rise to a swelling immediately behind the opening, which represents a localized distention of the canal and may attain a very large size. Such a distention of the canal has been mistaken for a double bladder.

Treatment.—The treatment of malformations of the ureter is very restricted. In some instances, abnormally placed terminations of the canal can be remedied by separating the distal end from its position and implanting it in whatever part of the bladder is most convenient for the purpose in each case. Whenever the operation can be done extraperitoneally, this should be done. Baker,[23] Davenport,[24] and Maxson[25] have each successfully transplanted into the bladder ureters which terminated in the female urethra, by dissecting the end of the ureter from its abnormal position, freeing it as far as the base of the bladder by incising the anterior vaginal wall; after this had been done, the ureter was inserted into the bladder through an incision made in it for the purpose and sutured to hold it in place.

Tuffier and Baum have also successfully implanted such ureters by a suprapubic operation.

Congenital malpositions and constrictions of the upper part of the ureter are usually discovered during operations upon hydronephrotic kidneys. In some cases the condition has been remedied by plastic operations upon the ureter and renal pelvis.

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CHAPTER XXI.

MOVABLE KIDNEY.

Definition.—The term *movable kidney* is used to designate an *abnormal* degree of mobility of the organ.

A floating kidney is one which has the congenital peculiarity of being provided with a membrane resembling the mesentery, and called the *mesonephron*, which is a prolongation of the peritoneum, and which, in greater part or wholly, envelops the kidney. Under these circumstances the organ lies within the peritoneum. The mesonephron attaches the kidney to the posterior abdominal wall, or to the spine. The cases reported are rare. In those which have been described the mesonephron has been long, and has thus allowed a wide range of mobility to the kidney in all directions and even across the vertebral column. Morris[1] cites several cases.

The division of these two conditions on an anatomical basis is the only one that seems to us to be logical. The distinction between them clinically, except by means of surgical exploration, is impossible; moreover, it is unimportant, since there is nothing to be gained by establishing it before operation, and the indications for surgical intervention would, if present, be equally applicable to either of the two conditions.

The Normal Mobility of the Kidney.—Under normal conditions the kidney has a certain degree of mobility which coincides with the upward and downward excursion of the diaphragm in its respiratory movements. The movement of the kidney within normal limits varies in different individuals. The writer has been at some pains to establish what these are, and has taken occasion to measure them in the living subject—this being the only way by which a proper conception of them can be obtained—in the course of many surgical operations which have allowed the kidney to be observed, and has found the distance traversed by the organ to vary from one-half of an inch to one and a half inches. This degree of mobility per se is never productive of trouble.

Etiology.—The causal factors of abnormal mobility of the kidney may be divided into two classes: (1) essential predisposing causes, and (2) exciting causes.

1. The essential etiological factors are unquestionably of an anatomical nature.

Wolkow and Delitzen,[2] as the result of observations and experiments,

concluded that this anatomical factor is the form of the paravertebral fossæ in which the kidneys rest on either side the spinal column. They asserted that in those persons with abnormally mobile kidneys these fossæ are more shallow and more widely open at their lower ends than in the case of individuals the mobility of whose kidneys is within the normal limits. In this way they accounted for the greater frequency of movable kidney in women than in men, and of the right as compared with the left one, since, according to their observations, the paravertebral fossæ of women are more open and more shallow than those of men, and are more so on the right side than on the left.

Allowing that these observations are correct, in so far as they concern the form of the fossæ, the writer cannot agree with the view of these authors, for the reason that abnormal mobility of the left kidney has been seen by him in the case of a young man whose left paravertebral fossa was quite as deep and quite as well closed as is the case in subjects in whom there has been no such abnormal mobility of the organ. Again, the normal range of mobility of the kidney carries its lower end below the inferior edge of the fossa in many instances, and there can, consequently, be no important restraining influence exercised by the fossa upon a further descent of the organ.

Atrophy of the Perirenal Fat Tissue as a Causal Factor.—Another theory put forward is that the undue degree of mobility of the kidney is to be referred to a wasting of the fat tissues of the perirenal envelope. This explanation is obviously inadequate, since great mobility of the organ has been observed in some persons having an abundant perirenal fat tissue; while, on the other hand, no abnormal mobility has been present in some individuals whose perirenal fat is much atrophied.

Relaxed Abdominal Wall as a Cause.—This has been declared to be the etiological factor in the production of the condition, and its greater frequency in the case of multiparæ has been cited in support of this idea. That this, too, fails to cover the whole ground is shown by the fact that movable kidney occurs in some instances in the persons of strong young men and unmarried women with perfectly firm abdominal walls; and, again, there are women with flabby abdominal muscles and relaxed abdominal walls who do not have movable kidneys. Moreover, were this the underlying cause of movable kidney in *all* cases, as has been asserted by some writers, we should find the largest number in the persons of old people with wasted muscles and flabby abdomens; but we do not find such a proportion as compared with persons who are younger.

General Enteroptosis.—This theory was put forward and defended by Glenard,[3] who attributed the downward displacement of the kidney

to the relaxation of the abdominal wall and decreased intra-abdominal pressure, and who declared that the kidney alone never became abnormally mobile, but that this condition of the organ was always associated with a general enteroptosis. This is also entirely contrary to the facts. That it is sometimes, perhaps often, the case, is true, but that movable kidney does exist independently of general enteroptosis is also unquestionably true, and equally so that it does not always take part in enteroptosis of the other abdominal viscera.

Downward Pressure of the Liver.—This has been thought to explain the frequent occurrence of abnormal mobility of the right kidney as compared with the left, but it certainly does not explain the left kidney cases, and does not account for the right ones, else why should not all right kidneys be abnormally mobile?

The Variation in Strength, Number, and Arrangement of the Perirenal Connective-tissue Attachments of the Kidney to the Surrounding Parts the True Causal Factor.—There is no tissue of the body that shows greater variation of the above-named qualities than the connective-tissue fibers of areolar tissue. That this is strikingly shown in those of the perirenal envelope may be seen by anyone who studies them. To this variation, the writer is convinced, is due the occurrence of movable kidney, and that it is chiefly to the *normal distribution* and development of these fibers and of the so-called perirenal fascia, which has been especially described by Sappey, Zuckerkandl, Englisch, Gerota, Glantenay and Gosset,[4] that the kidney is restrained within the normal limits of its mobility; abnormal mobility being produced by the failure of the full development of the same structures.

A rough but convincing experiment will persuade anyone of the truth of this view, viz., open the abdomen of a cadaver by an incision on one side the median line of the body, such as to give free access to the kidney. Place the tips of two fingers on the upper pole of the organ, without disturbing the intra-abdominal structures more than is necessary in order to reach it. Draw downward with the finger tips that rest on the upper end of the kidney. Under normal conditions it will be found that the organ descends from three-quarters to one and a half inches. Divide the outer leaf of the mesocolon and separate it, together with the colon, from its attachments to the anterior surface of the kidney. Now draw down again upon the organ, and its mobility will be seen to have been increased, but only to a very slight extent. Take away the connective-tissue fibers and the fat tissue from about the lower end of the organ. The mobility will be a little, but only a little, further increased. Break through the attachments of the same character that connect the lumbar fascia with the posterior surface of the kidney. The mobility will be seen to have been very much increased. Finally, break down the small

bloodvessels, nerves, and connective-tissue fibers, passing from the kidney to the under surface of the diaphragm. There is nothing now remaining to restrain the downward excursion of the organ except its main bloodvessels, and it will descend of its own weight if the body be placed upright, swinging, in so doing, toward the spinal column, being guided in this direction by the renal bloodvessels.

Now, when the structures just named as having been successively broken down are normally developed, a very considerable degree of force is required to displace the kidney from its normal position. If they are, on the contrary, defective, but little is demanded; and it is to this fact—inadequate development of these tissues—that the writer believes the abnormal mobility of the kidney is chiefly due. The same conclusion is reached by Glantenay.[5]

This would explain the occurrence of *all* cases of movable kidney, and show why the same *exciting* causes—blows, falls, lifting heavy objects, etc., become operative in one individual to produce movable kidney, and in another do not. It would explain why it is that *all* persons with relaxed abdominal walls *do not*, and why some with firm ones *do*, have movable kidneys. It tells us also why it is that the kidney does not *necessarily* participate in general enteroptosis of intraperitoneal organs. In short, it covers the ground with respect to the etiology of the condition in all cases, and it is the only explanation which does so.

Sex.—Movable kidney occurs much more frequently in women than in men. Keyes[6] gives the relative proportion of its occurrence as 20 per cent. in women to 2 per cent. in men.

Frequency.—Some physicians find abnormally movable kidney with extraordinary frequency. We have heard it asserted that 80 per cent. of all women examined in certain female out-patient clinics are found to have this condition. Curiously enough, but few *surgeons* are capable of discovering this extraordinarily large proportion, despite the fact that they must be credited with as well-trained touch and as knowledgeful a method of examination as their medical confrères possess.

In this connection the following table, taken from Keyes,[6] is of interest:

	Women.			Men.		
Observers.	Cases examined.	Movable kidney.	Per cent.	Cases.	Movable kidney.	Per cent.
Bergmann	905	40	4.41	828	40	4.8
Einhorn	543	112	20.00	772	14	1.81
Einhorn	832	240	28	1080	42	3.88
Matthieu	306	85	25			
Goddard-Danhieux	603	212	35	268	6	2.33
Suckling	100	42	42	100	6	6.00
Harris	126	71	56			

Keyes estimates the relative frequency of *right* as compared with *left* movable kidney as being 8 out of 10 cases.

Pathological Changes Secondary to Movable Kidney.—As a rule, abnormal mobility of the kidney produces no consequences of serious import. In many cases it produces none that are recognizable in life or postmortem. On the other hand, very serious, and even fatal, conditions are the result of the abnormal mobility of the organ in a certain number They are as follows: (1) *Hydronephrosis.* (2) *Fixation of the kidney in an abnormal position.* (See Illustrative Cases at end of chapter, Nos. 1, 2, and 3.) (3) *Gangrene of the Kidney.*

1. *Hydronephrosis and the Conditions Connected with Movable Kidney Which Lead to It.*—It is doubtless true that in a good many cases in which hydronephrosis has been attributed to movable kidney the real causal factor has been one or another of a number of congenital defects or malformations of the renal pelvis, ureter, or renal bloodvessels, but it is equally true that movable kidney is the causal agent of the hydronephrosis in other instances. The manner in which the mobility produces hydronephrosis is by creating kinks or sharp bends in the ureter. The following data bearing on this point are of interest:

Tuffier found 12 hydronephrotic kidneys in a series of 40 operations in cases of movable kidney. In 3 of them there was a sharp kink in the ureter close to the renal pelvis.

In an investigation with relation to this point the writer recently found 83 cases reported in the literature of the subject, in which it was clearly shown that the ureteral obstruction and hydronephrosis resulting from it depended upon abnormal mobility of the corresponding kidney.

In most instances of movable kidney it is probable that as the kidney descends the ureter is folded upon itself in a series of moderate curves, none of which are sharp enough to obstruct the flow of fluids through it. The permeability of a tube which lies in such a position can be well shown by pumping water through a hose which has been similarly placed.

This is the form given by the descending kidney to the ureter, if the organ is *wholly* freed from its attachments and allowed to glide downward in a cadaver placed upright.

If the ureter is fixed at some point, a sharp bend will be produced in it at that spot, as the kidney descends, and the passage of the urine through it is then prevented.

The ureter may be wholly occluded by a twist produced in it through the falling forward of the upper end of the kidney. Such a twist the writer has seen personally in one instance in which the lower pole of the kidney had been improperly attached by suture to the loin, and its upper end allowed to remain free.

Again, the whole kidney may rotate on its long axis, and then will produce a bend in its pelvis, or in the upper end of the ureter.

In whatever way the twists or bends are brought about the result is the same, namely, a suddenly produced renal retention. This condition will be more or less serious in its results according to the length of time it lasts, and according to whether the obstruction of the ureteral channel is complete or incomplete.

No. 4 of the illustrative cases at the end of this chapter is an example of intermittent obstruction of the ureter due to abnormal mobility of the kidney and of the means taken to relieve the recurring attacks prior to the performance of nephropexy.

That the abnormal mobility of the kidney bears a direct relation to the occurrence of intermittent hydronephrosis is shown by the fact that of a series of 83 cases of hydronephrosis collected by the writer, 33, or 39.7 per cent., showed at time of operation that there was a kink or twist of the ureter produced by movable kidney which was responsible for the production of the hydronephrosis.

2. *Fixation of the Kidney in an Abnormal Position.*—When this accident occurs in connection with a movable kidney its consequences may be very grave. It has so happened that the writer has been obliged to remove such kidneys in three instances.

(These cases are described at length in Nos. 1, 2, and 3, illustrative cases at the end of this chapter.) In each of them the patient became disabled, owing to the fact that a previously movable kidney became fixed in an abnormal position by adhesions.

3. *Gangrene of the Kidney.*—This grave accident is said to have occurred in consequence of torsion of the renal bloodvessels produced by the turning of the kidney upon its transverse or short axis.

Changes in the Kidney Substance Other than Those Due to Hydronephrosis or Pyonephrosis.—Morris[1] quotes Newman as having reported a case in which acute congestion of the kidney was seen in connection with the "crises" taking place in a patient with movable kidney, and in whom uremic symptoms appeared in consequence of torsion of the renal bloodvessels, as was shown at the time of an operation done for the relief of these symptoms.

Symptoms.—The symptoms of movable kidney are in part local to the kidney, in part referred to adjacent organs, and to the nervous system.

Pain.—The most characteristic symptom of movable kidney is pain, and the characteristic of this pain is, in typical cases, its sudden onset, its intensity, and its prompt subsidence upon the return of the kidney to its normal position, or upon such change of the position of the organ as

will remove the obstruction of the ureter caused by a twist or bend. In these respects the pain closely resembles that of renal colic due to calculus. In the writer's personal experience it differs from the pain in typical cases of renal calculus in that it does not usually radiate along the course of the ureter to the groin.

In many cases the typical "crises" are lacking, and the pain has the character of a more or less frequently recurring ache, or a feeling of weight or dragging sensation, usually referred to the loin. Sometimes the movement of the organ can be clearly felt by the patient.

The Urine in Cases of Movable Kidney.—Immediately succeeding the attacks of pain, when the latter occurs in the form of "crises," polyuria is present in greater or less degree. In some instances casts and albumin, and occasionally blood, appear in the urine immediately after the paroxysms of pain, and are present for variable lengths of time subsequently.

Jaundice and Gastro-intestinal Symptoms.—Jaundice occasionally, and gastro-intestinal symptoms frequently, are seen in connection with movable kidney.

Morris[1] refers to several cases in which jaundice is reported to have occurred in association with the attacks of renal pain.

One explanation offered of the occurrence of jaundice is that it is caused by direct pressure of the kidney on the bile ducts. This theory, as Morris observes, is neither borne out by observations made in the living subject nor by postmortem examinations.

Morris believes that the jaundice is probably produced by the partial closure of the lumen of the duodenum in the vicinity of the mouth of the common duct, this occlusion of the duodenum being, in turn, created by the dragging upon the bowel by the movable kidney. The connections between the intestine at this point and the kidney are bands of peritoneum passing from the one to the other in such a way as to attach them closely, and to make inevitable a narrowing, or even total occlusion, of the duodenum, when the kidney is displaced downward. Morris quotes cases reported by Franks and MacAllister in support of this view.

Gastro-intestinal Symptoms.—Nausea, vomiting, epigastric pain, constipation, excessive gas formation in the bowel or stomach, acid fermentation of the gastric contents are sometimes referable to the mobility of the kidney and its interference with the duodenum, as just described, or may be the result of general enteroptosis, with which the movable kidney is associated.

In enteroptosis, dilatation of the stomach, stasis and decomposition of its contents, and the systemic poisoning which results, are present.

In some cases these symptoms are acute, violent, and accompanied

by much pain. The attacks are then known under the name of "Dietl's crises," that author having described them in 1864. They are characterized by violent colics, vomiting, abdominal pain—usually epigastric—faintness, sometimes threatened collapse, abdominal distention, and constipation. They may closely simulate acute appendicitis. If due to the kidney's mobility and torsion of the ureter or of the renal blood-vessels the following things suggest that such is the fact:

1. The presence of tenderness, often accompanied by a peculiar sense of nausea, faintness, and pain—closely resembling that produced by injury of the testicle—if pressure is made upon the kidney.

2. Absence of localized pain and tenderness on pressure over the appendix.

3. Increase in size of the kidney and diminution of the urine during the attack.

4. Relief of the symptoms upon raising the hips of the patient when in a recumbent position, or by returning the kidney to its normal position by manipulation.

The increase in the size of the kidney under these circumstances is due to congestion and not to accumulation of urine in its pelvis.

Neurasthenic Symptoms.—Neurasthenic symptoms are undoubtedly produced by movable kidney in a certain number of the cases. It is equally true that neurasthenic patients, once they are informed that they have a movable kidney, refer all manner of ailments, aches, and pains to that organ as the cause, though, in fact, it may have nothing to do with their production. It is essential to distinguish between these two states, else the surgeon may make the grave mistake of counselling operation upon the kidney in the latter class of cases, in which it will bring no relief and will have been needlessly done.

It is the custom with many medical men to regard movable kidney as a trivial condition, and to ignore the serious consequences which result from it in some cases, attributing the symptoms connected with the kidney to neurasthenia, and being very skeptical as to the production of the latter condition by abnormal mobility of the organ. On the other hand, there are a certain number of surgeons who are far too ready to attribute various ailments and symptoms, which are, in fact, neurasthenic, to abnormal mobility of the kidney, and who see in an extraordinarily large number of cases evidences which appear to demand the performance of nephropexy. Both attitudes are wrong. Neither should be encouraged.

The points to be noted as aids in discriminating between symptoms of a neurasthenic nature which are erroneously referred to the renal mobility and those which really are referable to that condition, are:

whether the neurasthenia antedated the abnormal mobility of the kidney, or the reverse; whether there is marked displacement of the organ, which is the case if the kidney can be palpated and its movements readily felt; the sudden cessation of pain upon reposition of the organ in its normal position; the typical nature of the pain; the appearance and progressive course of neurasthenic symptoms subsequent to the occurrence of movable kidney; the presence of enteroptosis of other abdominal viscera; the occurrence of polyuria following the attacks of pain, after reposition of the kidney in its normal position. These points will ordinarily enable the surgeon to decide whether or not the abnormal mobility of the kidney is the cause of the neurasthenic manifestations.

Tumor in the Loin.—The presence of a movable tumor in the loin, having the shape and size of the kidney, is the most diagnostic feature of the condition.

FIG. 350

Method of examining the patient to detect movable kidney.

The examination should be made with the patient lying on the back and with the knees raised so as to relax the abdominal muscles (Fig. 350). The surgeon kneels by the side of the patient and places the fingers of one hand upon the front of the abdomen, a little below the free border of the ribs and on the line of the linea semilunaris. The fingers of the other hand are pressed against the loin just outside the outer border of the quadratus lumborum and near the lower border of the twelfth rib. The patient is then directed to breathe in deeply and to let the breath out again at once. During inspiration but *slight* pressure is made by the two hands upon the front and back of the body. With expiration, *deep* pressure is made by them. When there is an abnormal degree of mobility, the lower half or the whole of the kidney is felt to slip upward and downward between the fingers of the two hands, in accordance with the respiratory movements of the diaphragm.

Even when there is an abnormal mobility of the organ, it does not always descend so as to be palpable while the patient is lying on the back. It may be felt on one occasion, and on another the surgeon may fail to detect it. The examination should, therefore, be repeated before it is decided that an abnormal mobility of the kidney does not exist. The patient should also be examined when sitting up and bending slightly forward, and when lying upon the opposite side (Fig. 351).

Morris refers to a case in which he was unable to bring down an abnormally movable kidney after having replaced it in its natural position, though it had shortly before been freely movable and readily palpated.

The most characteristic thing to be felt when examining a movable kidney is the slipping of the organ between the fingers of the hands

FIG. 351

Method of examining patient to detect movable kidney.

placed as already described. The smooth surface, the rounded lower end, and its firm consistency and shape all convey a convincing sense to the touch of the examiner.

Unless the kidney can be felt in this way the diagnosis cannot be positively made.

Other Conditions Likely to be Mistaken for Movable Kidney.—Distended gall-bladder, mesenteric tumors, collections of gas or fecal masses in the intestine, ovarian and uterine tumors with long pedicles, and movable spleen have each and all been mistaken for abnormally mobile kidney.

A Distended Gall-bladder.—The most distinctive difference between the distended gall-bladder and movable kidney is the fact that the former lies so palpably against the anterior abdominal wall, and is, consequently,

so much more clearly to be felt and percussed. Again, the gall-bladder lacks the characteristic shape of the kidney. The summit of a distended gall-bladder may feel somewhat like the pole of the kidney, but it is apt to be less distinct; and then, too, it is, as we have said, pressed forward against the inner surface of the abdomen, whereas the pole of the kidney, with but few exceptions, is far back toward the loin and points downward. The summit of the gall-bladder lacks the peculiarly firm, solid consistency possessed by the kidney. The history of the case will, in most instances, point decidedly to one or the other of these two conditions, and aid in discriminating between them. *X*-ray examination and a skiagraph in cases of patients with thin abdominal walls, when taken by those especially skilled in the work, will, in many cases, show sufficiently clear outlines of the kidney to allow its position to be judged.

Tumors of the inner surface of the intestine, of the mesentery, and of the omentum are sometimes very difficult to distinguish from movable kidney. The writer, in one instance, felt convinced that he had to deal with a very movable kidney, which, upon operation, proved to be a fibro-adenomatous tumor growing from the inner wall of the small intestine, and having the shape and approximately the size of the kidney.

Such cases are rare, and, therefore, will not often cause difficulty in making the diagnosis. The same is true with respect to mesenteric tumors.

Ovarian or uterine tumors with long pedicles cannot be pushed upward and backward into the normal position of the kidney, whereas a kidney with the degree of mobility that might cause doubt in the diagnosis between it and either of the two other conditions *can* be returned to that position. The other tumors lack, moreover, the characteristic form of the kidney.

Prognosis.—Movable kidney per se is not a fatal disease. It may become so because of the secondary changes and complications to which it gives rise in a certain proportion of the cases. These have already been enumerated, and do not call for further comment. It must not be forgotten that patients may be reduced to a state of chronic invalidism if the kidney remains movable and gives rise to severe symptoms. Then, too, it must be borne in mind that the kidney is often but one manifestation of general enteroptosis, and that it may be responsible for but a small part of the patient's troubles.

Treatment.—Treatment of movable kidney falls under three headings: (1) *Hygienic.* (2) *Mechanical.* (3) *Operative.*

1. HYGIENIC TREATMENT.—With patients who are anemic and poorly nourished, outdoor life, good feeding, and exercises tending to strengthen the abdominal muscles and to improve the general nutrition may all be

of service in helping to retain the kidney in its proper place, either before or after surgical operation. Except in very mild cases, these measures cannot be relied upon to effect a cure, and in the severer forms they are usually unavailing.

2. Mechanical Treatment.—This consists in the application of one or another of various contrivances designed for the purpose of supporting the anterior abdominal wall and exerting upward pressure indirectly upon the kidney.

We shall confine ourselves to the description of one of these supports, which the writer has found to be of use in a few cases in preventing attacks of pain and in enabling the patients to take certain kinds of exercise, which they were unable to do without it.

Fig. 352

Mechanical contrivance to support movable kidney.

The contrivance consists of an elastic abdominal band, which laces up in front, and the width of which is maintained by upright pieces of whalebone set into it at intervals. On either side of the middle line of the band, in front and upon the inner surface, is attached a rubber bag, having the shape and position shown in Fig. 352. Each of them is provided with a rubber tube having a stop-cock. The bags can be inflated by pumping air into them through the tubes by a small rubber bulb provided with a nozzle, which fits into the ends of the tubes. The bags are made in such a form that their lower ends are larger, and, consequently, can be more widely inflated than the upper ones, which are narrower. In this way a graded pressure, greater below than above, is brought to bear upon the front of the abdominal wall.

The band is applied with the bags empty. It is then lightly drawn together by the lacing in front. Air is then pumped into the bags until they are moderately inflated and exert a firm pressure upon the lower part of the abdominal wall. Whatever further degree of pressure than this may be needed is best obtained by tightening the band by means of the lacing.

Mechanical treatment, of whatever sort it may be, rarely proves

curative. In some of the milder cases it succeeds in averting the attacks of pain and in enabling the patients to exercise. In these instances the kidney is kept comparatively near its normal position by the support.

Mechanical treatment of any sort should be supplemented by exercises which strengthen the abdominal muscles. One of the best means of doing this is by lying upon the back and raising the legs upward, with the knees held stiff and straight, and lowering them again. The exercise should be moderate at first, may be increased as the muscles become stronger.

3. OPERATIVE TREATMENT.—The operative treatment consists in the application of one or another of the numerous methods of performing nephropexy; that is to say, the operation designed for fixation of a movable kidney.

The different methods and the choice between them are discussed in the chapter on Operations on the Ureters, under the heading Nephropexy. In this section we shall consider merely the parts of the subject which concern: (1) The selection of cases suitable for operation. (2) When operation should be done. (3) What danger the operation carries with it and what benefit may be expected to result from it.

1. *Cases Suitable for Operation.*—All patients presenting the severer forms of the malady, in which we include those exhibiting neurasthenic symptoms of a severe character (gastro-intestinal disturbances which are not due to general enteroptosis of the abdominal viscera); those who present evidence of hydro- or pyonephrosis; those who have attacks of pain and disturbances of the renal function which can, with reasonable certainty, be traced to abnormal mobility of the kidney, are all suitable for nephropexy, and the operation should unquestionably be done. The most difficult point to decide in the question of submitting a patient to operation is that of determining whether or not the neurasthenic symptoms, when they are the conspicuous feature in the case, are to be referred to the abnormal mobility of the kidney. A large part of the adverse criticism which has been directed against the operation of nephropexy has been due to the failure of some surgeons to properly discriminate with reference to cause and effect in this particular factor of the cases.

2. *The Time at Which the Operation Should Be Done.*—The proper time to do nephropexy (in cases in which it is right to do it at all) is as soon as the diagnosis has been made.

3. *Results of Operative Treatment.*—That the operative mortality of nephropexy is very small may be judged from the following table of operations, which certainly does not underestimate the dangers of the procedure:

Operators.	Cases.	Deaths.	Mortality.
Edebohls	193	3	
Johnston	107	0	
Goelet	136	0	
Küster	99	2	
Morris	98	1	
Tuffier	75	2	
Noble	56	2	
Israel	52	0	
Triconi	32	0	
Rose	22	1	
Championnière	26	0	
Baldwin	34	0	
Lobstein	23	2	
Johnson	16	0	
Wolff	21	0	
Herzberg	10	0	
Total	1000	13	1.3

Late Results.—From a series of 253 other cases collected by the writer, in 158 of which the late results were noted at periods of from one to fifteen years subsequent to the operation, the following data are taken: cures, 132; greatly improved, 18; failures, 8. Absolute cures, 83.5 per cent.; failures in about 5 per cent.

This analysis we believe to be one which represents very fairly the operative results, both immediate and remote, in cases which are properly selected and in which operations have been done by surgeons of skill and experience.

The operative mortality attending nephropexy is one of the smallest connected with any surgical operation, and may be regarded as of trifling importance when advising the patient with regard to operation.

In the face of the very favorable results of nephropexy, in view of the grave dangers which attend the more serious forms of the malady, and the great discomfort, and often pain as well, which characterize many of the cases which are *not* actually of a dangerous nature, we unhesitatingly advise the performance of the operation of nephropexy in every instance in which the conditions that we have stated as appropriate for its application are present. Equally, we counsel that it shall not be done except when those conditions exist.

Illustrative Cases.

Case I.—*Movable Kidney Retained in Abnormal Position.*—A man, aged thirty years, in good health until two years ago. He then had typhoid fever. On recovering, began to have attacks of pain in the

right side of the abdomen, most marked at a point midway between the crest of the ilium and the free border of the ribs. The pain was at first moderate, but became progressively worse with the succeeding attacks. Its onset was sudden, and it ceased suddenly. The pain was always confined to the spot mentioned above. During one of the earlier attacks the patient noticed a movable tumor in the lower right side of the abdomen. At that time, and until six months ago, it could be readily pushed upward. When this was done the pain ceased. Six months ago and during the most severe attack of pain that he had had, he was unable to replace the tumor, and it remained low down in the right side of the abdomen. From time to time it caused him severe pain, and the suffering finally became so great as to entirely disable him.

Examination showed an immovable tumor in the place mentioned. It had the shape, size, and consistency of the kidney. It was tender to pressure, and, when pressure was made upon it, a feeling of nausea and faintness was produced. The lower end of the tumor was well below the line of the crest of the ilium.

Operation.—The abdomen was opened by an incision through the right linea semilunaris on a level with the umbilicus. The tumor was found to be the right kidney bound down in the abnormal position stated above, by dense adhesions which crossed its anterior surface. These were incised and an attempt was made to free the kidney from them. This was abandoned because of the tearing off of portions of the organ which remained attached to the adhesions, when the attempt was made to separate them.

On this account nephrectomy was done.

Uninterrupted recovery followed. The patient was under observation during the next five years, and remained in good health and free from discomfort throughout this time.

CASE II.—*Right Kidney Hydronephrotic and Fixed in Abnormal Position.*—A man, aged forty-four years. At the age of twenty-seven he sustained an injury to the right side. About a year later attacks of pain began in the region of the right kidney. The intervals between the attacks were long at first; later, they became shorter. During the attacks constipation was marked and the bladder was very irritable. The pain was rather indefinitely located between the crest of the ilium and the free border of the ribs. The attacks usually lasted about four days.

Examination showed moderate tenderness over the appendix and a sense of increased resistance on pressure over the right side of the abdomen about the umbilicus. No definite tumor was to be made out. Urine normal.

Operation.—The abdomen was opened by an incision through the right linea semilunaris. The right kidney was found to be displaced, so that it lay upon the lateral aspect of the bodies of the vertebræ. It was hydronephrotic and could not be mobilized without tearing it. An aberrant artery crossed the aorta to the lower pole of the organ. In ligating this vessel, as was subsequently proved, the ligature was placed too close to the ascending colon. This caused a minute sloughing of the intestine at this point, which gave rise to a septic process which had, as one of its features, a septic pneumonia, which caused the patient's death on the thirteenth day after the operation.

CASE III.—This case was that of a man aged thirty-five years, and presents similar features to the two preceding ones. The left instead of the right kidney was affected in this instance, and there was no preceding injury, as in Case II. Attacks of pain of increasing frequency had occurred during the past two years. The pain was localized very definitely in the left side of the abdomen, midway between the iliac crest and the ribs, in the axillary line. The patient finally became disabled.

On examination an ill-defined, smooth, immovable tumor was found at the above-named point. The urine was normal.

An exploratory lumbar operation showed the left kidney to be firmly bound down by adhesions, as in the last two cases.

At a subsequent operation the adhesions were in large part divided and the indurated mass of connective tissue surrounding the organ and its capsule were freely incised. The kidney could not, however, be mobilized. From this operation entire relief resulted and lasted for six months. The pain then returned, and nephrectomy was performed. Uninterrupted convalescence. The patient was under observation for three years, during which time he was free from pain and in good health.

CASE IV.—A case which illustrates the clinical phenomena presented during the attacks of pain and the disappearance of symptoms following nephropexy.

A strong and previously healthy woman, aged twenty-seven years, shortly after an illness which weakened her, and during which she lost much weight, began to have attacks of pain resembling renal colic in the left renal region. At first they were of moderate severity; later, they became more severe; and at the end of a year they had practically disabled her.

The attacks began suddenly. The pain was located by the patient in the left loin, and was accompanied by faintness, pallor, more or less nausea, and sometimes by sweating. It ceased as suddenly as it began. During the attack the left kidney was markedly enlarged and descended

well below its normal position. It was freely movable, and on pressure upon it the patient experienced a peculiar sickening sensation, which, from the description given, may be assumed to have resembled that produced in men by pressure or by a blow upon the testicles. The attacks could always be brought to an end by placing the patient on her back and raising the hips. When this was done, the left kidney could be felt to slip back into its normal place. More or less profuse polyuria always followed these "crises."

Nephropexy was performed upon the left kidney. Complete relief of all symptoms resulted and has continued ever since—eleven years. A few months after this operation the right kidney, which was also abnormally mobile, caused the same symptoms on that side that had formerly been present in connection with the left kidney. Nephropexy was done on the right kidney, and resulted, as the first operation had done, in absolute and permanent relief of all symptoms.

One of the noticeable features of this case was the direct production, by the renal condition, of neurasthenic symptoms which had never been present previously and their entire disappearance subsequent to the second operation.

Both kidneys, at the time of the operations, were found to be freely movable, and the right one, when it descended, produced a well-marked kink in the ureter, which, however, was not sufficiently sharp to wholly occlude it. Neither kidney was hydronephrotic.

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CHAPTER XXII.

SUBPARIETAL INJURIES OF THE KIDNEY AND URETER.

SUBPARIETAL INJURIES OF THE KIDNEY.

Definition.—Laceration or tearing of the kidney produced by violence inflicted upon the external surface of the body without creating an open wound of the latter.

Etiology.—The injury results from: (1) Falls, blows, or crushing force inflicted *directly* upon the back or side of the body at or near the level of the kidney. (2) *Indirectly*, when the same forces are expended upon the front of the abdomen and transmitted to the kidney from that point. (3) By the force of muscular effort alone. (See Illustrative Cases at end of chapter, Nos. 1 to 8 inclusive.)

Mechanism by Which the Injury to the Kidney is Produced.—The conclusion reached by Küster[1] from experiments was as follows: That the essential element causing rupture of the kidney is hydraulic pressure acting through the bloodvessels and renal pelvis, which causes the organ to burst on receiving the blow, whether the latter be directed against the back and ribs immediately overlying the kidney or indirectly exerted from the anterior abdominal wall. Flaccid kidneys whose ureters and bloodvessels have not been tied and from which the fluids have been allowed to escape after removal of the organ from the body exhibit, on being thrown to the floor violently, only superficial rents, whereas if the kidney be injected with fluid, the ureter and bloodvessels tied, and the experiment be repeated, the organ will be ruptured, producing in bursting, deep wounds, often involving the whole thickness of the kidney, and, for the most part, radiating from the hilum to the periphery.

Morris[2] attributes an important role to the ribs in the production of the injury, believing that the laceration is brought about by their impact upon the kidney, directly transmitted, when the blow falls upon the back or side, and indirectly when it is caused by muscular spasm, which, he believes, takes place in the cases in which the force is exerted upon the front of the abdomen, the kidney in either case being driven against the unyielding resistance offered by the vertebral column.

Frequency of the Injury.—The relative frequency of occurrence of subparietal rupture of the kidney may be judged by the following figures:

In 2610 postmortem examinations made in the course of ten years at the Middlesex Hospital there were but 12 instances of subparietal laceration of the kidney.

Goldstein[3] reports that 22 cases occurred in the course of twenty years at the Friederichshain Hospital.

Waldvogel[4] says that there were 21 cases in the clinic of König, in Göttingen, in the course of five years.

Wyss,[5] 14 in Kronlein's clinic in twenty years.

At the Boston City Hospital the writer found 27 cases recorded during the preceding fourteen years.

Frequency with Relation to Subparietal Injuries of Intraperitoneal Structures.—Makins examined the records of 292 cases of abdominal contusions. In 89 of them the organs injured were as follows:

Kidney	35
Intestine	22
Liver	15
Spleen	10
Bladder	4
Mesentery	3

Classification of Cases.—Strictly speaking, only those cases come under the heading of subparietal rupture of the kidney in which the kidney and its adnexa alone are injured; that is to say, the kidney, renal pelvis, ureter, renal bloodvessels, fibrous capsule, and the fatty perirenal envelope. Owing, however, to the frequency with which the peritoneum overlying the kidney and intraperitoneal organs are involved in connection with the renal injury, and since both conditions often demand surgical treatment at the same time, we have included those in which such complications were present. Other and more remote injuries complicating the renal trauma we have omitted, as they find a more appropriate place for discussion in works on general surgery. With this explanation, the cases fall, first of all, into the two classes: (1) *Uncomplicated*, and (2) *complicated*, and are further subdivided into partial and complete ruptures.

1. *Uncomplicated Cases.*—Those in which the injury is limited to the kidney or its adnexa.

2. *Complicated Cases.*—Those in which the peritoneum overlying the kidney is torn or in which some intraperitoneal structure is injured in association with the renal injury.

3. *Partial or Incomplete Rupture.*—Cases in which the laceration does *not* involve the entire thickness of the kidney and does *not* extend beyond the fibrous capsule of the organ.

4. *Complete Rupture.*—Cases in which the contrary of the conditions specified in the last paragraph is true

The later complications, such as aneurysm of the renal artery, hydronephrosis, infection and suppuration of the structures injured, fall into

their proper places in the order of the above classification, but do not alter its arrangement. They will be discussed in due course.

The largest series of cases brought together for purposes of statistical record and analysis, prior to the year 1904, was that of Watson,[6] published in 1903, consisting of 603. It has been utilized by us in this chapter whenever its data have been of value in the demonstration of one or another point in connection with the subject.

FIG. 353

Laceration of the kidney from body being compressed between car-buffers; nephrectomy; recovery. (Author's case.)

FIG. 354

Laceration of the kidney incurred by a fall upon the side. Spleen also torn, nephrectomy; death. (Author's case.)

Under the classification which we have adopted, uncomplicated cases constitute a large majority of the whole number; thus, in the series of 603, referred to above, there were 487 of this class and 116 of the other.

Nature, Extent, and Varieties of the Injury.—*Character of the Renal Lacerations.*—The wounds of the kidney parenchyma may take any direction. The larger number traverse the organ more or less in the line of its transverse diameter.

Every degree of injury, from slight superficial rents to complete disin-

tegration of the kidney, is met with. Among the severer forms it is not uncommon to find the organ torn quite in two, or one of its poles completely separated and lying loose in the retroperitoneal space. In the majority of cases the lacerations communicate with the renal calices or pelvis. Figs. 353, 354, and 355 illustrate some of the varieties of the renal lacerations.

FIG. 355

Rupture of the kidney, tearing the organ nearly in two. There was also a rent in the renal vein, *a*, and another in a branch of the renal artery, *b*. (Author's case.)

Repair of Renal Tissue after Injury.—The remarkable power of repair and of maintaining a useful degree of functional activity possessed by renal tissue, even after the organ has sustained severe injury, has been well demonstrated by experimental research, as well as by clinical and postmortem observations.

Some experiments of Dolgoff[7] are of interest in this connection. Dolgoff found:

1. Severe laceration of the kidney of a dog, even the tearing of the organ in halves, did not result fatally.

2. The animals survived the excision of the cortical portion of one kidney, and of one-half of that of the other one, provided the portions removed were taken away at intervals, bit by bit. If, however, the whole of this amount of the renal tissue was removed at once, the animals died in a short time.

3. That wounds of the medullary portion were of graver consequence than those of the cortex. Severe injuries of the former parts of both kidneys inflicted simultaneously were always speedily fatal.

4. If one kidney was removed, subsequent injury to either the cortex or medullary portions of the other always resulted fatally, although death was often delayed for a considerable time.

5. Wounds of the kidney healed more readily when the fibrous capsule was preserved, and also if, when the latter was torn, the edges of the wound in it were united.

6. The renal tissue remaining after injury or removal of other portions of it showed remarkable reparative power.

Conditions Resulting from Injury.—*Immediate.*—These are: (1) Hemorrhage. (2) Infarction. (3) Extravasation of urine. (4) Anuria. (5) Disintegration of the kidney. (6) Rupture of the renal pelvis or the ureter.

Later.—(1) Secondary hemorrhage. (2) Aneurysm of the renal artery. (3) Suppuration within or around the kidney.

HEMORRHAGE.—Hemorrhage appears in the following forms: (1) Hematuria. (2) Intrarenal (hematonephrosis). (3) Subcapsular. (4) Perirenal. (5) External ecchymosis. (6) Intraperitoneal.

Hematuria.—Hematuria will be present except when one or another of the following conditions exist: (1) Tearing across of the ureter or renal pelvis. (2) Laceration of the renal artery. (3) Destruction of the kidney itself. (4) Blocking of the ureter by blood clot. (5) Laceration situated in the kidney substance and not communicating with the renal pelvis or calices.

Hematonephrosis.—This term, as Morris points out, is sometimes improperly used to designate subcapsular hemorrhage. It should be confined to the extravasation of blood which takes place into one or all of the following structures: the renal parenchyma, calices, or renal pelvis.

In order to have hemorrhage take this form, the blood must be sufficiently abundant to clot, and thus not be able to run through the ureter; the renal pelvis must be intact or not torn enough to allow the blood to escape through it into the perirenal tissue, and the same thing must be true of the fibrous capsule of the kidney. Finally, of course, the renal bloodvessels must not be torn, the circulation of blood in the kidney must not have been arrested, and the organ must not be disintegrated.

The amount of blood which collects is sometimes very large, but if it becomes too great for the fibrous capsule or renal pelvis to sustain the pressure which it puts upon them, they will be torn and allow it to escape. When this does not take place, the pressure upon the renal parenchyma may arrest the secretory function and cause atrophy of the organ.

Subcapsular.—If the fibrous capsule is not torn, and the renal wounds communicate with the surface of the kidney, blood collects between the latter and the fibrous capsule, separating it to a greater or less extent from the organ and forming a tumor of a size corresponding to the amount of blood poured out. To this condition the term subcapsular hemorrhage is applied.

If the capsule is strong enough not to be ruptured by the pressure of a large amount of blood beneath it, the kidney may be so compressed as to cause engorgement of its bloodvessels, and suppression of urine may result in consequence. Morris says that in most cases this is averted by rapid absorption of a certain amount of the blood poured out and the relief from pressure thus afforded.

Perirenal.—The source of hemorrhage in this form may be the renal parenchyma, the renal bloodvessels, or the bloodvessels of the perirenal fat envelope. When blood is from the renal parenchyma or intrarenal portions of the bloodvessels of the kidney, the fibrous capsule must have been torn and the wounds of the kidney substance must communicate with its surface in order to produce this variety of hemorrhage. When from the main renal bloodvessels, the blood will find its way directly into the perirenal, retroperitoneal tissues of the loin. Hemorrhage of this sort is ordinarily excessive in amount, usually fills the whole of the retroperitoneal space of the loin, and may push in between the two layers of the mesocolon, pressing the bowel forward and forming an immense tumor.

When the perirenal hemorrhage arises from the bloodvessels of the fatty envelope of the kidney, it is rarely very profuse.

In some cases in which the fibrous capsule is not torn, the hemorrhage occurs simultaneously in the intrarenal, perirenal, and subcapsular forms.

Spontaneous Arrest of Hemorrhage.—This occurs very commonly in perirenal hemorrhage, sometimes even when the renal bloodvessels have been torn; it is brought about by the increasing pressure exercised by the peritoneum, which becomes more and more tense over the growing collection of blood behind it. There is a marked difference in the degree of tension observed in the overlying peritoneum in different individuals. When it fits tightly, it will naturally arrest the bleeding more effectively and quickly than when it is relaxed.

The intrarenal pressure exerted by the stretched fibrous capsule and renal pelvis in cases of hematonephrosis will frequently arrest further bleeding in the cases in which hemorrhage takes that form.

External Ecchymosis.—In a few cases more or less extensive ecchymosis of the scrotum and inguinal region occurs, as the result of the passage of blood which collects in the retroperitoneal space, downward in the course of the spermatic bloodvessels and outward to the surface through the external inguinal ring.

Intraperitoneal Hemorrhage.—In this form of hemorrhage, when it arises from the kidney itself, from its bloodvessels, or from those of the perirenal fatty envelope, the blood gains admission to the abdominal cavity through a rent in the peritoneum overlying the kidney, the rent being made simultaneously with the injury inflicted upon the kidney, or being produced subsequently by the pressure of blood extravasation into the perirenal tissues; the latter is of rare occurrence, however.

Intraperitoneal hemorrhage may proceed from injury of intra-abdominal structures incurred at the same time with that of the kidney. If the peritoneum overlying the kidney is torn in such a case, the intra-abdominal hemorrhage may arise from the kidney and a wounded intra-abdominal organ simultaneously, while, if the peritoneum is not torn, the two hemorrhages will be distinct, one proceeding within the peritoneal cavity, and the other in the retroperitoneal space outside it. As a matter of fact, however, the peritoneum is usually torn in this class of cases. The pressure exercised by the peritoneum upon the kidney and the blood proceeding from it, when the membrane is not torn, is absent when it is injured, and hence spontaneous arrest of the bleeding does not often occur under these circumstances.

The relative frequency of the cases with associated intraperitoneal injuries and with laceration of the peritoneum overlying the kidney is shown by the following figures:

Total number of cases	603
With associated injuries of intraperitoneal structures or organs	116
Of these 116, the peritoneum overlying the kidney was torn in	62
Intraperitoneal injuries without tearing of peritoneum	34

In addition to the above, there were 20 others in which the overlying peritoneum was torn, but in which there was no injury of intraperitoneal organs.

Special Features Connected with Hemorrhage.—One of two things takes place in the extravasated blood in all of the above-described forms of hemorrhage. It is either absorbed gradually or it becomes infected and suppurates.

In some cases of intrarenal hemorrhage, blood clots formed in the ureter may become adherent to the inner surface of the latter and wholly occlude its canal. In this case there will follow the changes in the kidney which are described elsewhere in connection with the subject of renal retentions.

When blood flows from the injured kidney to the bladder in sufficient quantities, blood clots may form there and give rise to retention of urine.

The blood of perirenal hemorrhage may remain liquid, but usually forms a clot, which, if of large size, completely covers over the kidney and conceals it. It is often difficult, when seeking to expose the kidney, to distinguish the organ either by touch or sight under these circumstances.

Morris calls attention to the fact that the extravasated blood may remain unabsorbed for very long periods after the receipt of the injury, and cites, as an example, a case in which this was demonstrated eighteen months after the injury had occurred.

Infarction and Destruction of the Kidney.—Infarction of the kidney occurs in some cases and is due to injury to or thrombus formation in a branch of either the renal artery or vein, so that the circulation is cut off from the part of the kidney dependent upon it for its blood supply. The infarction appears as a wedge-shaped area, at first having a deeply congested appearance, later a characteristic fawn color, and, finally, presenting the appearance of necrosis in the part involved. The importance of recognizing such areas of infarction is obvious with reference to the surgical treatment, and will be referred to again when dealing with that part of the subject.

Destruction of the kidney will inevitably follow injury to the renal artery or vein of such nature as to cut off the circulation of the organ, whether because of the escape of blood from the artery or by thrombus formation in either artery or vein.

The organ may be destroyed by actual disintegration resulting from the extreme violence of the injury inflicted upon it.

EXTRAVASATION OF URINE.—*Perirenal, Intraperitoneal, and Causal Relation of to Peritonitis.*—Perirenal extravasation of urine occurs only when the ureter or renal pelvis is wounded, or when the calices and renal pelvis communicate directly with the outer surface of the kidney through the wounds of the parenchyma and the fibrous capsule.

Experiments appear to show that the surfaces of wounds of the parenchyma do not secrete urine, hence urinary extravasation does not take place from them in these cases.

Urinary extravasation, furthermore, will not take place in any case in

which the injury is such as to have caused an immediate suppression of the renal secretion, as would occur, for example, if the kidney were disintegrated, or its blood supply seriously interfered with or cut off.

In the cases in which the conditions last named do *not* exist, and in which there is no obstacle to the escape of urine into the perirenal tissues, the secretion will mix with the blood and go to form with it the retroperitoneal collections of fluid that are commonly present in such cases, and which are of varying extent, according to the quantities of the extravasated fluids contributing to their composition.

Suppuration in the area occupied by the extravasated urine takes place if infection occurs. This frequently happens, and the probability of suppuration is much increased in the cases in which urine constitutes or forms a part of the extravasation into the perirenal tissues.

Suppuration does not, however, always follow, and the extravasation may gradually disappear or become encysted, in the latter case giving rise to the condition known as pseudohydronephrosis.

Urinary Extravasation into the Peritoneum and Peritonitis.—Numerous experiments and clinical observations have been made for the purpose of determining the effect of the presence of urine, or mixed urine and blood in the peritoneal cavity.

Quervain,[8] in an interesting article, summarizes the opinions and observations made by various writers upon this subject. He quotes the following as holding the opinion that, except for the aid that may be derived from surgical intervention, all patients with intraperitoneal extravasations of blood and urine die of septic peritonitis. Among those sharing this belief are Küster, König, Albarran, Schede, Petroff,[9] and Edler.[10] Grawitz,[11] on the other hand, as far back as 1888, asserted that the danger from lacerations of the peritoneum in cases of subparietal ruptures of the kidney was owing to the free exit afforded for the escape of *blood* into the peritoneal cavity through the rent in the peritoneum, and denied that the presence of *urine* was necessarily of serious consequence. Tuffier had already demonstrated experimentally that *no urine* flows from the surface of lacerated renal wounds, and also that urine from the kidney, introduced into the peritoneal cavity, does not cause peritonitis, provided but a single introduction is made, and that it is done gradually, or even repeatedly, if only the intervals are long enough between the introductions. Whereas, if the flow of the fluid into the peritoneal cavity is continuous, peritonitis is produced.

Israel and Grawitz found that urine which was allowed to enter the peritoneal cavity from the end of a divided ureter did not kill the animals with which they made their experiments sooner than four or five weeks, and Quervain obtained similar results. The peritoneal

cavity quickly protected itself from the effects of the extravasated fluids by adhesion and walling off.

If the adhesive walling off failed, and steady flow of the fluid into the peritoneal cavity took place, peritonitis did result.

ANURIA.—In order to have anuria occur in connection with subparietal injury of the kidney, one or another of the following conditions must exist: Destruction or very extensive laceration of one kidney and functional incapacity of the other kidney due to disease or suppression of a normal organ's secretory function by reflex inhibition. Injury of both kidneys, or of a fused kidney; cutting off of the blood supply or interference with the renal blood circulation by injury or thrombosis of its main vessels, plugging of the ureter with blood clot and kidney debris, and functional incapability of the other kidney in combination.

Anuria usually follows immediately upon receipt of the injury when any of the conditions favoring its occurrence exist. It may, however, arise later, because of the disturbance of the kidney's secretory function by pressure of intra- or perirenal hemorrhage.

SECONDARY HEMORRHAGE.—This may occur in connection with any of the forms of hemorrhage already mentioned. In a general way it may be said that it is due to dislodgement of a thrombus from the renal bloodvessels; the breaking up of a clot in the renal pelvis, or to its escape through a rent in the fibrous capsule or through the renal pelvis, which may be produced by infection at some time after the receipt of the injury, or because of long-continued pressure from the accumulated blood within the kidney, in the renal pelvis, or beneath the renal capsule. Finally, it may be produced by engorgement of the kidney due to interference with the natural blood circulation in the organ, the blood in this case exuding from the vessels into the calices and renal pelvis slowly and tardily.

ANEURYSM OF THE RENAL ARTERY.—Morris[2] and Hochenegg have written interesting descriptions of this condition. Morris collected 19 cases of aneurysm of the artery or of its branches, 7 of them being due to causes other than trauma. The following data are taken from Morris:

"Two varieties are found after injuries: (1) small, sacciform aneurysms, the walls of which are formed by some or all the coats of the artery; and (2) large false aneurysms, the walls of which become more or less firmly matted to the surrounding organs and tissues.

"The true or sacciform aneurysm—always apparently of small size —if of traumatic origin, may be associated with an extravasation of blood or of blood and urine, both being the consequences of the same accident.

"The aneurysm may be a late, as well as an immediate, consequence

of injury. That it may be caused by an accident which either slightly or extensively damages the kidney; that it often ultimately leads to absolute destruction by atrophy of the whole or a considerable part of the organ; and finally, that there is great risk attached to the operative treatment, and certain death if such treatment is not adopted, should be an additional inducement to explore early every kidney which is seriously damaged by accident.

"If a sacciform aneurysm burst into the renal pelvis, profuse hemorrhage is the result; the bladder may become distended with blood, and blood may flow from the urethra.

"The blood may distend the pelvis and calices, and, producing complete absorption of the renal parenchyma, create true hematonephrosis. It may be extravasated entirely within the capsule, between it and the renal parenchyma, or partly within the renal capsule and partly into the perinephritic tissue, or entirely outside the capsule.

"The matting together of the sac of the aneurysm and of the adjacent structures is so intimate that it is impossible to distinguish one from the other.

Symptoms.—"A false aneurysm, no matter how formed, sooner or later always causes a tumor, and nearly always gives rise to hematuria.

"The tumor may be so large as to fill half the abdominal cavity.

"The tumor is but slightly movable, if it is not actually fixed. It is not generally tender to pressure or the seat of acute pain. Pulsation is remarkable by its absence.

Treatment.—"The only prospect of saving life is by nephrectomy and the removal of a part or the whole of the aneurysmal swelling."

Morris advises that the operation be begun as an exploratory measure, as it is impossible to distinguish between a hematoma due to the ruptured vein or lacerated kidney and an aneurysm.

The lumbar incision should be extended by adding a forward arm to it as soon as the true condition is made out.

It is dangerous to remove much of the clot. As soon as the laminated nature of the tumor is discovered the pedicle should be promptly secured.

Morris refers to his own case as a warning for neglecting this precaution. In some cases adhesions constitute a serious obstacle to the performance of the operation. Of the 12 traumatic cases, 9 were false aneurysms, 1 doubtful, and 2 were sacciform.

"Of the 9 false aneurysms, 2 occurred from the bursting of sacciform aneurysm; 1 followed, after a time, from the yielding of a thrombus in the ruptured artery without having been preceded by a sacciform aneurysm; 5 were the immediate consequence of rupture of the artery; in 1 the nature of the aneurysm was not mentioned."

Among the pathological changes noted by him are the following:

"As long as a sacciform aneurysm remains unruptured, it seems not to produce any distinct changes in the kidney or parts around it. . . . If a sacciform aneurysm bursts into the renal pelvis, profuse hemorrhage results. The patient may die as a result of the hemorrhage.

"When a false aneurysm forms, whether as a result of the rupture of a sacciform aneurysm, or directly by the giving way of the artery, serious damage is generally done to the kidney, and extensive pressure changes are wrought in the surrounding tissues and organs. The blood may distend the pelvis and calices, and, producing complete absorption of the renal parenchyma, create a true hematonephrosis, or it may be extravasated between the renal parenchyma and the capsule, or partly within the renal capsule and partly into the perinephritic tissue, or it may be entirely outside the renal capsule.

"The kidney may have undergone complete or partial atrophy."

Morris points out that the sac of the aneurysm and the capsule inclosing what remains of an atrophied kidney may be difficult to distinguish one from the other.

"When an intrarenal branch of the artery is the seat of the aneurysm, the blood poured out upon the rupture of the aneurysm makes its way into the calices and through the calices into the renal pelvis and the ureters."

Morris further says that in cases in which the blood is retained beneath the renal capsule, the latter may eventually burst, involve the overlying peritoneal covering, and let the blood escape into the peritoneal cavity. The renal parenchyma may also be destroyed by the pressure upon it by subcapsular hemorrhage in connection with aneurysm of the renal artery. In some instances the colon may be displaced toward the median line by the pressure of the tumor caused by the blood escaping from the aneurysm. The liver or the spleen may be displaced upward by the same pressure.

Speaking of adhesions between the outer surface of the sac and neighboring structures, Morris says that they are sometimes dense and very difficult to separate, while sometimes the contrary is the case.

One of the interesting features noted is with regard to the presence of blood and urine together in the aneurysmal sac; this has been reported in two cases; the urine in this condition is derived from the ureter or renal pelvis, with which communication has been established by ulceration due to pressure of the aneurysm. Ulceration from the same cause has been found to have taken place in the overlying peritoneal covering, which was perforated in one case as a consequence. Still another interesting observation is that of Hilton, quoted by Morris. In this

case a small aneurysm of one of the branches of the artery was present, a false aneurysm had been formed by the rupture of the small vessel on which the true aneurysm itself was situated, so that there were two aneurysms side by side, one true and one false.

TRAUMATIC HYDRONEPHROSIS AND PSEUDOHYDRONEPHROSIS.—True hydronephrosis is a rare sequence of the injury. When it does occur it is due to pressure upon the ureter or renal pelvis by renal aneurysm, or to malpositions of the kidney resulting from the injury and causing kinks or twists of the ureters, or to contraction and pressure of the ureter resulting from adhesions. An occasional cause is found in the permanent blocking of the artery by an adherent blood clot.

It should not be forgotten that hydronephrosis of the injured kidney may have been present before the accident. Such was probably true in the case reported by Watson. (See Illustrative Cases, No. 8.)

Some of the cases in which the kidney has been ruptured by what would seem to be a force inadequate for the purpose may perhaps be explained by this fact.

Pseudohydronephrosis is the term given to collections of urine inclosed within a limiting membrane or sac connected with the exterior of the kidney, having no communication with the interior of the organ if the wound through which the urinary extravasation took place be healed; or having a connecting channel with the kidney's interior if the wound has not healed. This channel may be difficult to find, and is sometimes very devious.

The outer membrane of the sac is of inflammatory origin, and is difficult to distinguish from the fibrous capsule of the kidney in some instances, owing to which and to the resemblance of the cavity within the membrane to a dilated renal calyx, the condition is easily mistaken for a true hydronephrosis.

INFECTION AND SUPPURATION.—The injuries resulting from the accident invite infection, which reaches the injured area either through the blood current, from the intestine, or in the form of an ascending infection from the bladder.

In this connection the following experiment of Delbet[12] is of interest: He produced infection of the kidney in rabbits—after lacerating, crushing, or bursting the organ—by injecting into the ears of the animals 1 c.c. of a solution containing one drop of a virulent culture of the Bacillus communis coli to 10 c.c. of the fluid. These animals soon afterward died, and rich colonies of the bacillus were found in the renal parenchyma of the injured kidneys, and also in the perirenal tissues. In control animals with sound kidneys this was not the case.

Suppuration occurs in the following forms: (1) Pyonephrosis. (2)

Suppurative nephritis. (3) Perinephritic abscess. (4) Purulent peritonitis.

Frequency.—The frequency with which infection and suppuration take place in relation to the whole number of the cases of the injury may be seen by the following figures:

	Cases.	Infection.	
Grawitz	90	22	
Küster	227	27	Cases without intraperitoneal complications.
Watson	486	68	

In the 68 cases collected by Watson, suppuration appeared in the following forms:

Perinephritic abscess	38
Peritonitis	9
Pyonephrosis	6
Suppurative nephritis	4
Not specified	11
Total	68

Pyonephrosis.—Infection and suppuration may be delayed for considerable periods after the injury. Thus some cases of pyonephrosis are reported in which there was no evidence of its existence for two or three months following the accident.

The occurrence of this form of suppuration is not frequent.

The collection of pus and urine retained within the kidney and its pelvis may be evacuated spontaneously through the ureter into the bladder, or by breaking through the renal parenchyma and its fibrous capsule, or through the renal pelvis; in the two latter conditions, perirenal suppuration will be produced.

It may also break into the peritoneal cavity and infect the latter. In a few cases fistulous communication has been established with the intestines, the stomach, or with the bladder, urine and pus making their escape through these channels.

Suppurative Nephritis.—Suppuration of the renal parenchyma appears in the form of a single focus or in that of disseminated multiple abscesses. Infection in these cases is probably of hemic origin. If the patient survive, more or less destruction of the kidney substance is caused by these conditions.

Perinephritic Abscess.—Suppuration assumed this form in more than one-half of the whole number of cases in which suppuration occurred, namely, in 38 of the total number of 68.

When perinephritic inflammation, leading to perinephritic abscess, takes place, suppuration may be delayed in some instances for a

comparatively long time after the accident—between three and four months, and even longer.

If not interfered with, the abscess gradually works its way to the surface of the loin, or upward to, and sometimes through, the diaphragm and about the liver, or downward beneath Poupart's ligament into Scarpa's triangle in the same manner as psoas abscess of spinal origin.

In other cases, the pus breaks through the peritoneum and causes septic peritonitis; and, again, through the diaphragm and into the pleural cavity, whence it may enter the lung and even discharge itself through the bronchi.

The larger number of fistulæ are those which communicate with the surface of the loin. Their tendency is to discharge for considerable periods, but the majority heal at length spontaneously.

Symptoms and Diagnosis.—IN UNCOMPLICATED AND TYPICAL CASES.—There are three cardinal symptoms in this class of cases, as follows:

1. Signs of shock or of internal hemorrhage.

2. Hematuria.

3. The appearance in the loin of the injured side of an increased area of percussion dulness, or of a tumor.

Other symptoms are: *vomiting; pain,* the latter generally referred to the injured kidney and its immediate neighborhood, sometimes extending forward onto the front of the abdomen or downward to the groin and the testicle; *spasm of the abdominal muscles of the injured side; anuria; ecchymosis.* Some or all of these follow immediately upon or soon after the accident.

Later symptoms depend for their production upon the occurrence or non-occurrence of one or another of the secondary pathological changes which have been noted under the heading of pathology. These are: (1) One or another form of secondary hemorrhage, viz., hematuria, intrarenal, perirenal, and (2) suppuration in one or another form, viz., intrarenal, perirenal.

IN CASES WITH ASSOCIATED INTRAPERITONEAL INJURIES.—The symptoms in this class are those which are usual to injury of intraperitoneal structures, viz., abdominal pain, distention, spasm of the abdominal muscles, tympanites, and obscured liver dulness in the case of escape of gas from the intestine, repeated vomiting, and the evidence of intraperitoneal hemorrhage in the form of free fluid in the peritoneal cavity.

Later symptoms in this class of cases depend upon the occurrence of infection and suppuration, of which more will be said later on in the course of the text.

IMMEDIATE AND EARLY SYMPTOMS.—*Shock and Signs of Internal Hemorrhage.*—Shock in varying degrees of severity, corresponding with

the seriousness of the injury inflicted, follows immediately upon the accident in the great majority of cases. Exceptionally, it is absent.

Shock has been reported as "delayed" in some cases which are of special interest. The writer, upon investigating such of these as have furnished proof by postmortem examination or by operation of the actual conditions that have been present, has found that in every instance it has not been "delayed" shock, but delayed hemorrhage that has been the cause of the symptoms attributed to shock.

In the great majority of instances, shock, even when severe, passes off in the course of a few hours after the accident. In some, however, it is prolonged, and then is apt to be of serious import. Here, again, there may well be confusion between the symptoms of shock and those of hemorrhage.

The characteristic which best serves to distinguish shock from hemorrhage is that, while in the latter the symptoms are progressively more serious, in the former they become less so as time passes.

SYMPTOMS DUE TO HEMORRHAGE.—The bleeding which takes place from the kidney as a result of subparietal laceration of that organ is manifested *locally and objectively* in one or more of the following ways: Hematuria, tumor of the loin, and by the evidence of free fluid in the peritoneal cavity in the cases in which the overlying peritoneum is ruptured; the *general* signs of hemorrhage, when the bleeding is sufficient to produce them, viz., sighing respiration, pallor, weak, rapid, and irregular pulse, accompany the local manifestations just named.

Hematuria.—Blood in the urine was present in 80 per cent. of the cases in the series collected by Watson.[6]

Hematuria following the accident is not per se proof that the kidney is lacerated. The patient to whom the accident has happened may have had some previous condition of the urinary tract which may cause the bleeding. Such conditions, for example, as renal or vesical calculus, or tumor of the bladder or kidney, might account for the blood in the urine without the existence of rupture of the organ. In such cases, however, there will usually be the history of preceding hematuria or other symptoms which are characteristic of the existing disease. It should not be forgotten that hematuria is excited in certain individuals upon very slight provocation. Morris refers to persons in whose urine blood appears after riding a hard-gaited horse, and to others with whom it follows palpation of the kidney in the course of a surgical examination. The amount of blood in these cases is never large.

The sudden cessation of hematuria, when the amount of blood in the urine has been in considerable quantity, is significant, and indicates the occlusion of the ureter by blood clot, and very probably a new access of bleeding which has produced the clot.

The quantity of blood in the urine varies in different cases, from being enough merely to slightly tinge the urine to being so great as to fill the bladder with blood clot and to cause retention.

Time of Appearance of Hematuria Subsequent to the Accident.—Of 117 cases in Watson's series in which this time is noted, hematuria is said to have occurred with the first urination following the accident in 106; in 11 it was delayed for periods varying from twelve hours to five days. Morris quotes Rayer as reporting one instance in which the delay was eleven days.

Duration of Hematuria.—In 167 of the cases of Watson's series in which the duration of hematuria was noted, the average time was found to be eight days, while the longest periods reported in 7 cases were as follows: fifty-six, forty-six, forty-two, twenty-eight, twenty-one, twenty-one, and eighteen days.

Absence of Hematuria.—The causes of the absence of hematuria have already been spoken of. The significance of the absence of blood from the urine, especially when the other signs of the injury are grave, is serious, since it is likely to be due to the presence of one or another of the following conditions: laceration of the renal bloodvessels, disintegration of the kidney, or tearing across of the renal pelvis or ureter. In other cases it is owing to permanent occlusion of the ureter by an adherent blood clot.

Delayed Hematuria.—In some cases the appearance of blood in the urine is delayed. This may be of serious significance. It is sometimes due to the dislodgement of a thrombus from a branch of the renal bloodvessels which communicates with one of the calices.

Recurrent Hematuria.—Secondary hemorrhage in this form is apt to be of grave import. It is of comparatively rare occurrence.

TUMOR IN THE LOIN, OR INCREASED AREA OF PERCUSSION DULNESS.—When either of these symptoms develops *immediately, or within a few hours after the receipt of the injury*, it indicates the occurrence of one or another of the following conditions: (1) *Extravasation of blood, or of blood and urine, or of urine alone, into the perirenal tissues.* (2) *Subcapsular hemorrhage.* (3) *Hemorrhage into the interior of the kidney or renal pelvis.*

When these symptoms come on at a later time after the receipt of the injury, they represent one or another of the following things: (1) *Secondary hemorrhage.* (2) *Hydronephrosis.* (3) *Pyonephrosis.* (4) *Perinephritic abscess.* (5) *Extravasation of urine due to secondary rupture of ureter or renal pelvis.*

Tumor in the Loin Due to Extravasated Blood.—When hemorrhage into the perirenal tissues is but moderate, its presence will be represented by

an increased area of percussion dulness. When of greater extent, it will be manifest in the form of tumor in the loin, varying in size according to the amount of blood that is poured out.

In the excessive hemorrhages in which the blood proceeds from very extensive lacerations of the renal parenchyma, or from the main stems of the renal bloodvessels, the whole retroperitoneal space from the diaphragm to the pelvis may be occupied by an immense collection of blood. Such hemorrhages—in some even of those in which the main bloodvessels are torn—are often spontaneously arrested by the pressure exerted upon the extravasated blood by the increasing tightness of the overlying peritoneum.

Tumor in the Loin Produced by Subcapsular or Intrarenal Hemorrhage.—Subcapsular and intrarenal hemorrhages are apt to produce a tumor of more circumscribed form than is the case with perirenal hemorrhage, but this connot be relied upon to distinguish the one from the other.

Morris[2] draws attention to the fact that retroperitoneal hemorrhage in the loin sometimes results from traumatism which might well have involved the kidney, but which, as a matter of fact, fell upon another part, such as the quadratus lumborum, or psoas muscles.

Increase in Size of the Tumor.—When this occurs suddenly and is rapid, or, if taking place after the swelling in the loin has already come to a standstill, it is probably due to secondary hemorrhage.

Sudden Diminution in Size or Disappearance of the Tumor.—The tumor in the loin may become much smaller, or suddenly disappear. When this happens, it is due to rupture of the renal pelvis, the fibrous capsule, or the overlying peritoneum, any one of which may give way, because of having been bruised at the time of the injury; or, in the case of the two former, because of the pressure of blood clot inclosed by them; or, later, by the weakening of any of the three membranes by suppuration. Clots of intrarenal hemorrhage may, after being confined in the pelvis and calices, be passed into the bladder through the ureter, and sudden disappearance of the tumor be brought about in this way.

Extravasation of Urine.—The surfaces of the lacerations of the renal parenchyma do not secrete urine, hence no urine is contributed by these parts of the organ when extravasation occurs. Urinary extravasation presupposes the existence of a laceration communicating interiorly with calices or renal pelvis, and externally with the perirenal tissues by laceration involving the outer surface of the kidney and its fibrous capsule; or a rent in the renal pelvis itself, or in the ureter, through which the urine escapes directly into the surrounding tissues.

Urinary extravasation may occur early or late after the injury. It will, in either case, rapidly form a tumor in the loin; its occurrence may be

conjectured by the co-existence of anuria or oliguria, together with a increasing tumor in the loin and the absence of hematuria; the latter because of failure of the urine to reach the bladder.

PAIN AND SPASM OF THE ABDOMINAL MUSCLES—Besides the characteristics already spoken of in connection with pain, it may be mentioned that it sometimes occurs in the form of renal colic, such as is seen in cases of renal calculus. This is due to the obstruction of the ureter with blood clot. The pain which is seen in cases of perinephritis and perinephritic abscess is spoken of under those headings. It occurs then as a later symptom.

Pain which is present immediately after the accident is of variable duration; it may continue for a week or more. This is not usually a serious symptom.

In the *complicated cases* pain is generally an evidence of peritoneal infection; when this occurs, it is distinct from the pain produced by the injury per se; it appears, as a rule, after an interval of a few days, and has the characteristics of the pain of peritonitis.

Tenderness on pressure over the injured kidney is always present and may continue for a good while—sometimes two and three weeks or more.

OLIGURIA, ALBUMINURIA, AND ANURIA.—More or less well-marked oliguria of varying duration is a frequent accompaniment of the renal injury. It is not a serious symptom unless it continues longer than the first few days, and is very marked.

Albuminuria is sometimes seen after all blood has ceased to appear in the urine. When casts and renal epithelium are associated with it, it is due to traumatic nephritis. In a few cases this view has been strengthened by the gradual disappearance of these elements from the urine in the course of the convalescence, and by the knowledge that there has been no renal disease present prior to the accident.

Anuria of short duration—twelve to twenty-four hours—is quite often seen in these cases. When not longer than this its significance is not necessarily grave, though until it has ceased to be present it must always be a source of anxiety. Short-lived anuria is usually attributed to the effect of reflex inhibition upon the other kidney, which, according to some writers, can only occur when it is not wholly normal, while others think it possible when the second kidney is perfectly normal.

Anuria of long duration is a very grave symptom, since it points to the existence of one or another of the following conditions: injury of both kidneys, a solitary or a fused kidney, disintegration of the injured kidney or cutting off of its blood supply by injury of the renal artery or vein, or disease of the kidney of the other side in combination with these conditions.

Anuria, instead of occurring at once, may appear later. It is then probably due to injury or engorgement of the renal parenchyma by gradually increasing pressure from blood clot or to suppuration.

ECCHYMOSIS.—Ecchymosis in the groin, perineum, scrotum, and inner side of the thigh is regarded as being a very reliable sign of rupture of the kidney. The course taken by the blood in its passage from the kidney to the outside of the body through the inguinal canal has already been described.

This ecchymosis may appear at any time between the end of the first twenty-four hours and ten days or more.

VOMITING.—This is a very common symptom. It follows immediately or soon after the accident in most cases, and may be repeated more or less frequently during the first twenty-four hours or so without having serious significance. When, however, it appears after that interval, or, having already been present, if it continues, it usually indicates the occurrence of infection of the peritoneum, and then has a correspondingly grave meaning. Under the latter circumstances, other signs of peritonitis will develop.

SYMPTOMS INDICATING THE OCCURRENCE OF INFECTION AND SUPPURATION.—(The chapter on suppurative diseases of the kidney treats of all of these conditions, including such as arise in connection with trauma. The reader is referred for further information upon the subject to the chapter on Suppurative Diseases of the Kidney).

COMPLICATED CASES.—*Cases in Which the Peritoneum is Torn, or in Which there Are Intraperitoneal Associated Injuries.*—The presence of free fluid blood in the peritoneal cavity is the most constant and certain symptom seen in connection with this class of injuries.

The most profuse bleeding is seen in connection with injuries of the spleen and of the liver, and when there is a severe laceration of the kidney, together with a rent in the overlying peritoneum, the amount of blood in these cases is excessive, and one wonders, on opening the abdominal cavity and seeing it literally filled with blood, why the patient has not already bled to death.

The tearing of the peritoneum, if there is no intraperitoneal organ injured, is not necessarily followed by intra-abdominal hemorrhage from the kidney, for the blood often clots and stops up the rent in the membrane, so that but little escapes through it. When the clot is disturbed, as it must be if the kidney is to be exposed in the course of an operation, very profuse bleeding usually ensues.

There is no means by which it can be determined before operation whether intraperitoneal hemorrhage is proceeding from the kidney through a rent in the peritoneum or from an injured intraperitoneal

organ. When the liver or spleen is seriously wounded, the hemorrhage is apt to be more rapid and alarming than when it comes from the kidney through a torn peritoneum, for the reason that, in the case of the two former injuries, there is no pressure exerted to control the bleeding such as there sometimes is upon the renal hemorrhage by the overlying peritoneum, even when the latter is torn.

In the cases in which intraperitoneal injuries are associated with that of the kidney, shock is usually much more marked.

The other signs of involvement of the intraperitoneal structures are also apt to be more conspicuous; that is to say, there is more spasm of the abdominal muscles, abdominal distention and tympanites. In case of rupture of the intestine, gas escaping into the peritoneal cavity may obscure the liver dulness. It is also true that in some cases very serious, even fatal, intraperitoneal lesions have been present without being suggested by any characteristic symptoms.

Cases in Which there Are no Intraperitoneal Associated Injuries, but in Which the Patients Present Symptoms Which Usually Characterize Intraperitoneal Lesions.—Any or all of the symptoms mentioned in the last paragraph as characteristic of intraperitoneal injuries may be manifested in the absence of such lesions. This was noted in 18 of the series.[6] In 8 of them the fact was verified by laparotomies, and in the other 10 convalescence was so rapid that it seemed improbable, to say the least, that there should have been an intraperitoneal lesion of such gravity as that suggested by the symptoms.

Treatment.—The treatment of subparietal injuries of the kidney is: (1) Palliative and expectant. (2) Operative.

Palliative and Expectant Treatment.—This comprises the following measures: absolute rest in bed; ice-bag to the injured loin; measures to overcome shock—that is to say, heat, stimulants and subcutaneous injections of saline solution.

Clots should be removed from the bladder if they are formed there in sufficient quantity to cause obstruction to the escape of urine. Narcotics should be given to overcome pain. Morris warns with regard to the possibility of starting secondary hemorrhage or causing a renewal of hemorrhage by allowing the bowels to be actively moved.

Operative Treatment.—This includes the following measures:

1. Nephrotomy, for the purpose of evacuating intrarenal collections of blood; or, at a later stage, of pus.

2. Partial resection of the kidney in cases in which the injury is confined to a portion of the organ.

3. Nephrectomy, in cases of extensive injury or laceration of the renal bloodvessels, or for the purpose of arresting hemorrhage.

4. Incisions, for evacuating perirenal abscess.

5. Laparotomy, and whatever procedure may be called for by the special intraperitoneal condition found to be present.

The Choice of Method of Treatment.—In this particular subject analysis of statistical data is of more value than is usually the case for determining the best course to be taken.

The tables which follow are taken from Watson's article, published in 1903, to which reference has already been made. The general conclusions and inferences which may be drawn from them are given later in the text.

(The complicated cases are those in which there are intraperitoneal injuries associated with that of the kidney.)

TABLE I.—OPERATIVE MORTALITY WITH RESPECT TO TREATMENT.

Total number of cases, 562. Deaths, 190. Mortality, 33.8 per cent.

	Cases.	Deaths.	
Uncomplicated	447	113	25.0 per cent.
Complicated	115	77	66.9 "
	562	190	
Treated expectantly.			
Uncomplicated	273	81	29.0 per cent.
Complicated	56	51	91.0 "
	329	132	40.0 "
Treated operatively.			
Uncomplicated	174	32	18.3 "
Complicated	59	26	44.0 "
	233	58	28.4 "

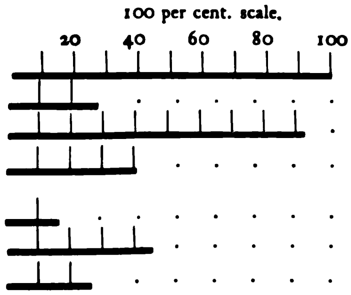

TABLE II.—CAUSES OF DEATH AND METHODS OF TREATMENT.

		Cases.	Deaths.
Uncomplicated cases treated expectantly		273	81
Deaths due to hemorrhage	25		
" " suppuration	22		
" " anuria	14		
" " shock	4		
No data	16		
	81		

Table II.—Causes of Death and Methods of Treatment (Continued).

		Cases.	Deaths.	Mortality (p. c.)
Uncomplicated cases treated operatively		174	32	18.3
Deaths due to hemorrhage	13			
" " suppuration	9			
" " anuria	9			
" " shock	1			
	32			
Complicated cases treated expectantly		56	51	91.0
Deaths due to hemorrhage	31			
" " suppuration	3			
" " anuria	9			
" " shock	2			
Cause of death not stated	6			
	51			
Complicated cases treated operatively		59	26	44.0
Deaths due to hemorrhage	11			
" " suppuration	7			
" " anuria	2			
" " shock	4			
	24			
No data in	2			
	26			

Table III.—Cases Treated by Operations other than Nephrectomy.

Uncomplicated cases.	Cases.	Deaths.	Remarks.
Lumbar nephrotomy	11	2	Other kidney injured in both
Lumbar incision and drainage	53	3	Per. hem., 2; abscess, 1.
By aspiration	14	1	Peritonitis.
By laparotomy	11	1	Peritonitis.
Lumbar incision and suture of the renal wound	8		
By partial resection	2	0	
	99	7	7 per cent. oper. mortality.

TABLE III.—CASES TREATED BY OPERATIONS OTHER THAN NEPHRECTOMY (CONTINUED).

Complicated cases.	Cases.	Deaths.	Remarks.
Laceration of overlying peritoneum; treated by lumbar incision and drainage	3	1	Due to hemorrhage.
The same condition treated by laparotomy, tampon, and drainage	2	2	1 peritonitis; 1 hemorrhage.
Laceration of liver and peritoneum; treated by laparotomy and tampon . .	3	1	Hemorrhage.
Treated by laparotomy and suture of liver wound	1	0	
Laceration of spleen and peritoneum; treated by splenectomy; kidney not touched	2	0	
Treated by tamponing spleen	2	2	Peritonitis, 1; hemorrhage, 1
Laceration of mesentery, laparotomy, and ligation	1	1	Peritonitis.
Contusion of descending colon; suture of bowel	1	0	
	15	7	

TABLE IV.—CASES TREATED BY NEPHRECTOMY.

Total number of cases, 119. Deaths, 36. Operative mortality, 30.2 per cent.

Uncomplicated.	Cases.	Deaths.	Per cent.
Lumbar, primary	42	12	28.5
" secondary	22	3	13.6
Abdominal, primary.	6	1	
" secondary	5	1	
Complicated			
Lumbar, primary	5	3	
" secondary	6	4	
Abdominal, primary	30	10	
" secondary	3	2	
Total	119	36	30.2

Causes of Death.—The following figures give the relative number of deaths due to the several conditions which proved fatal in connection with lumbar and abdominal nephrectomy in complicated and uncomplicated cases respectively:

TABLE V.—CAUSES OF DEATH.

UNCOMPLICATED CASES.		COMPLICATED CASES.	
Lumbar nephrectomy.	Cases.	Lumbar nephrectomy.	Cases.
Hemorrhage and shock	11	Hemorrhage (intraperitoneal)	2
Sepsis	3	Sepsis (suppuration in both)	2
Peritonitis	1	Peritonitis	3
	15		7
Abdominal		Abdominal	
Hemorrhage and shock	1	Hemorrhage (spleen, 2; liver, 1; kidney, 4)	7
Peritonitis	1	Shock	3
		Peritonitis	1
		Pneumonia	1
	2		12

Summary of Statistical Data.—The points of special interest in connection with the above analysis of data are as follows:

1. Irrespective of the nature of the cases (that is to say, whether uncomplicated or the contrary), the operative treatment was attended by but little more than one-half the mortality of the cases treated expectantly. The most striking difference, as would be expected, is seen in connection with the complicated cases to which each of the two different methods of treatment was respectively applied. Almost the entire number of the patients treated expectantly died, while 66 per cent. of those treated operatively lived.

2. The two most fatal factors are hemorrhage and suppuration, 80 of the total number of 190 deaths being caused by the former and 41 by the latter.

The other causes of death are shock and anuria; 34 deaths were due to the latter and 11 to the former of these conditions. No data were given with respect to the causes of death in 24 of the cases.

3. There is a striking difference between the small death rate attending the operative procedures other than nephrectomy and that which follows nephrectomy. This is owing to the nature of the cases rather than to that of the operations per se, nephrectomy having been performed in the most serious, and the other surgical procedures in the less serious cases.

4. Shock plays but a small part among the causes of death.

Hemorrhage is the condition which most often demands prompt surgical intervention. Doubt may sometimes arise as to whether the symptoms are due to shock or to hemorrhage, but the question can usually be decided within a short time. The evidences of shock are at their height immediately or soon after the accident, while those of hemorrhage become more marked as time passes.

Cases Suitable for Expectant Treatment.—1. The milder forms of the injury.

2. The cases in which there is reason to believe that both kidneys have been injured, the signs being external evidence of injury on both sides, tumor in both loins, and anuria.

3. Cases in which there are injuries of other parts of the body of such grave character as to make futile any operative treatment of the renal lesion.

Cases Demanding Operative Treatment.—1. All in which there is evidence of progressive hemorrhage, *e. g.*, increasing pallor, pulse of declining strength and increasing rapidity, sighing respiration, and, locally, a tumor in the loin which is increasing in size; or an increasing amount of free fluid in the peritoneal cavity in the cases complicated by intra-abdominal injuries.

2. Hematuria which persists for a long time, even though the quantity of blood is at no one time large; hematuria in which there is a large amount of blood, even though it has not lasted long; hematuria which recurs after having ceased; sudden cessation of a previously profuse hematuria, and, if there is no reason to believe that both kidneys are injured, absence of hematuria.

There were 8 cases in the series in which fatal hemorrhage took the form of hematuria. In 7 of them it occurred as secondary hematuria. In the remaining case death was due to long-continued hematuria, in which the blood was at no time excessive in quantity.

3. Anuria which continues for more than thirty-six or, at most, forty-eight hours, and if there is no reason to believe that both kidneys are injured.

4. Cases in which there is evidence of intra- or perirenal suppuration or of peritoneal infection.

Surgical Methods and Their Choice.—(The technique of the different surgical procedures will be found in the chapter on the Technique of Operations on the Kidney, under their respective headings.)

In Cases Not Complicated by Intraperitoneal Injuries.—In this class of cases the lumbar incision is always the method of choice for approaching the kidney, whether the indication for surgical interference is hemorrhage or suppuration.

When a freer field is demanded by the immediate necessity of arresting bleeding, or because of the large size of the kidney, or conditions connected with renal or perirenal suppuration, the lumbar incision should be enlarged by one or another of the supplementary incisions which are described in the chapter on the Technique of the Operations on the Kidney.

In Cases Complicated by Intraperitoneal Injuries.—In this class of cases, the approach should always be through a laparotomy incision, preferably through the linea semilunaris of the side of the injured kidney, because of its giving access to both the renal and the intraperitoneal lesions at the same time, *and because the intraperitoneal organ injured will always be on the same side as the injured kidney.* There was no exception to this rule in the whole series.

The cases in which there is an association of the intraperitoneal and renal injuries are among the most trying of surgical emergencies, and demand quick wit and unhesitating action. The blood pours out in a stream from the abdominal incision, obscuring entirely the source from which it proceeds, and making it impossible, in many instances, to determine it except by the sense of touch.

The first step should be to seek the source of the *greatest part of the hemorrhage.* This will probably be an injured intraperitoneal organ, *which will always be one that is on the same side as that of the lacerated kidney.* If the left one be injured, the chances are great that the intraperitoneal organ implicated is the spleen. If the right kidney, it will probably be the liver that is involved in association with it. The next most probable source of the intraperitoneal hemorrhage will be the kidney itself, the blood entering the abdominal cavity through a rent in the peritoneum overlying the organ. When there is no rent in this part of the peritoneum, and, consequently, the kidney is not contributing to the intraperitoneal hemorrhage, whatever bleeding may be taking place from the kidney behind the peritoneum should be disregarded for the time being, and the entire effort should be directed to checking the flow of blood from the injured intraperitoneal structure. The reason for taking this course is because of the fact that the tension of the overlying peritoneum will control sufficiently the renal hemorrhage, and if we attempt at the outset to arrest the bleeding from the kidney, the pressure of the peritoneum upon the blood clot surrounding the organ must be removed in order to reach it; and, furthermore, the removal of the blood clot will be almost certain to cause a renewal of active bleeding from the kidney laceration or from its vessels, and we shall then have the two sources—renal and intraperitoneal—of hemorrhage, active at the same time, and thereby greatly add to the difficulties of the situation.

When the bleeding from the intraperitoneal organ has been controlled, the attention should be turned to arresting that which proceeds from the kidney.

The steps taken to control the bleeding which arises from the intraperitoneal structures named will be determined by the special one of them which is involved. The spleen is difficult to suture, owing to the friability of its texture. The liver, on the other hand, can be successfully sutured in many instances.

Ligatures should be applied to torn mesenteric bloodvessels, and injured parts of the bowel should be resected or sutured according to the nature of the wounds.

Despite the writer's failure in his only two attempts to save the lives of patients with laceration of the kidney and the spleen by splenectomy, his belief is that the removal of the latter organ, if it be seriously injured, would afford the best chance of success under these circumstances, applying at the same time the most conservative measure possible to the kidney that will arrest hemorrhage.

Manner of Dealing with the Renal Hemorrhage in Cases in Which the Overlying Peritoneum is Torn.—As soon as the intraperitoneal structure which is furnishing the greater part of the hemorrhage has been dealt with, attention should be turned to arresting the renal hemorrhage. For this purpose the rent in the peritoneum should be enlarged by the fingers and the blood clot occupying the retroperitoneal space should be swept out. In doing this, care should be taken to avoid tearing off parts of the kidney which are already partially detached. It is very difficult sometimes to distinguish them from the blood clot in which they are buried. It is, on this account, better to remove at first the portion of the blood clot which lies below the site of the kidney.

When the clot is removed, furious hemorrhage is very likely to arise from the wounded kidney or from its bloodvessels.

Cases in Which Nephrectomy Should Be Done.—If the main bloodvessels of the kidney are torn, or if there is extensive destruction of the renal substance, nephrectomy should be done; in either case, however, the first step should be to arrest hemorrhage. It is usually impossible to pick up the injured vessel while the blood is pouring from it and concealing the whole field of operation, and the bleeding must be arrested before this can be done. There is but one way to do this, which is by compression of the vena cava or the aorta, as the case may be, the former when the vein is the source of the hemorrhage, the latter when it is the artery. When this has been done, and the blood has been sponged from the loin, the vessel can be found with less difficulty and tied.

In cases in which an aneurysm of the renal artery or of one of its

branches has been formed subsequent to the accident, nephrectomy will also be necessary. The performance of the operation is very difficult under these circumstances. Suppuration of the kidney may necessitate nephrectomy at some later time.

Resection of Part of the Kidney.—As a general principle, as much as possible of the kidney substance should be saved; for this purpose the most seriously injured part of the organ may be resected if the remainder of it is not too greatly damaged.

Suture of the Renal Wounds.—In the cases in which the renal lacerations are not too extensive they should be sutured when possible rather than tamponed. In this connection the remarkable power of spontaneous repair possessed by the kidney, to which reference was made in the earlier part of the chapter, should be borne in mind.

Nephrotomy, Tampon of the Renal Wounds, and Drainage.—Lumbar nephrotomy should be applied for the purpose of evacuating intrarenal clots of blood or freeing the ureter from them, and for controlling intrarenal hemorrhage in the cases in which the wound does not open upon the surface of the kidney and has not broken through the capsula vera. *Tampon* of the nephrotomy incision is the best measure to employ, to such lacerations of the renal substance as are too extensive to make suture appropriate, or in cases in which the patient's condition is very critical, and in which hemorrhage from the renal substance must be stopped in the shortest possible time.

Drainage of the field of operation should, in our judgment, always be made through the loin, whether the operation has been a lumbar or an abdominal one, except in connection with the more trifling forms of injury.

Retention of Urine Due to Collection of Blood Clots in the Bladder.—When this occurs, the bladder should be emptied by the Bigelow evacuating apparatus, which is used in the operation of litholapaxy.

Anuria.—When anuria takes place, and if, at the same time, there is no evidence of injury of the other kidney, a lumbar nephrotomy will sometimes disclose a collection of blood in the renal pelvis, or in the ureter, and thus furnish an opportunity to relieve the condition by evacuating the clot. In a few cases the anuria may be produced by pressure upon the renal substance by a large subcapsular clot.

Cases Illustrating Rupture of the Kidney Due to Muscular Effort Alone.

1. (Kellerman.[13]) Rupture of the kidney from muscular exertion. A man, making a sudden spring backward, felt a severe pain in the left

lumbar region. Slight hematuria for the next four days, then fever. On the eighteenth day a large perinephritic abscess opened through the lumbar incision. Complete recovery in eight weeks.

2. (Hensgen-Siegen.[14]) A man lifted a heavy woman, who was ill, from one side of the bed to the other. In doing so he felt a sharp pain in the back. Hematuria for three days. Three weeks later the urine was perfectly normal.

3. Seventeen-year-old boy, strong and muscular, lifted a very heavy weight. Pain in the lumbar region. Hematuria. This lasted for thirteen days. The blood was abundant. Right renal region very sensitive. On his leaving his bed hematuria, which had ceased, returned a few days afterward. The patient's condition continued to be poor for a considerable period, and was so at the time of the report.

4. (Franz.) A man carrying a heavy weight, bent sharply backward. He was seized with sudden pain in both kidneys. Profuse hematuria followed three hours afterward and continued for fourteen days. On the eighth day after the accident, chill, followed by fever; chills repeated several times in the course of the next twenty-four hours. Expectant treatment. Condition critical for several days. Recovery.

5. A man ruptured his kidney by the effort made in catching a heavy sack of meal as it fell from the back of a cart, behind which he was walking.

6. A man ruptured his kidney in bending forward suddenly to avoid striking a heavy burden he was carrying against an archway, beneath which he was about to pass.

7. A man ruptured his kidney with fatal result by the muscular effort made by him when *delivering a blow* at an opponent with whom he was boxing.

8. (Watson.) Rupture of a kidney, probably already hydronephrotic, by the muscular effort made by a woman in reaching up and drawing down the upper sash of a window, which she was washing.

A strong and, so far as she was aware, perfectly healthy woman, upon making the effort described above, was seized by severe pain in the right kidney. She fainted almost immediately, and, upon recovering, vomited once. Hematuria was noted in the second passage of urine following the accident, and, in moderate quantities, blood continued to be present in the urine for the next two or three days.

She remained in bed for a few days; then began to go about again, but did not resume her work because of a feeling of some tenderness and discomfort in the right kidney. These feelings slowly increased, and at the end of the third week a tumor of considerable size

was detected by her attending physician. The swelling occupied the right side of the abdomen and soon became prominent anteriorly. At the end of the fourth week there began to be some fever, and, for the first time, pus appeared in the urine.

Operation June 2, 1903 (five weeks after receipt of injury).—Lumbar incision parallel with outer border of the quadratus lumborum muscle, subsequently enlarged by the addition of a second cut parallel with the twelfth rib.

FIG. 356

Kidney ruptured by the muscular exertion made in pulling down a window. Infection of kidney later. Pyonephrosis; nephrectomy; recovery. (Author.)

The kidney was found to be enormously distended and pyonephrotic. Nephrectomy was done, and the lumbar wound drained.

Across the middle of the kidney was a laceration extending from its outer convex border nearly to the renal pelvis. The condition of the organ is shown in the accompanying illustration (Fig. 356). The patient made a slow but sound recovery.

Campbell (quoted by Morris[2]), Voit, and Wagner report further cases of rupture of the kidney by muscular effort alone.

CASE ILLUSTRATING TOTAL DISINTEGRATION OF THE KIDNEY. — 9. (Agrikow.) The right kidney of a patient aged twenty-four years was ruptured subparietally. The symptoms were hematuria, a tumor in the right loin, and, on the fourth day, fever.

On the fifth day a laparotomy incision was made, and a large quantity of blood was evacuated from the abdominal cavity. A lumbar counter-opening was made for drainage.

The fever continued after the operation; a large quantity of ammoniacal urine came through the lumbar wound. On the sixth day after the operation the abdominal wound had healed.

On the ninth and twelfth days large pieces of necrotic kidney tissue

were discharged through the lumbar incision. After this healing followed rapidly.

A Unique Case with Respect to the Manner in Which the Injury to the Kidney was Produced.—10. (Watson.) The patient fell a distance of twenty feet, striking the ground upon his hands and knees. Severe shock, marked pain and tenderness in the region of the right kidney, and an increased area of percussion dulness in the right lumbar region were the symptoms immediately following the accident.

Hematuria, in moderate degree, was present only with the first urination after the receipt of the injury. There was a noticeable decrease in the amount of urine secreted during the first three days. The urine was clear and normal, except the first passed after the injury, which, as has already been said, contained blood.

A tumor developed in the right loin within the first three hours after the accident, and slowly increased in size in the course of the next six days, at which time it occupied the entire loin and right side of the abdomen, pushing the ascending colon far over toward the median line and distending the right side of the abdomen. The tumor evidently represented an enormous extravasation of blood, which had issued from the lacerated kidney or its bloodvessels, and which had not been fatal to the patient because of its gradual progress.

Operation.—On the sixth day after the accident the blood clot and the kidney were exposed by the paraperitoneal incision for nephrectomy.

An enormous collection of blood, partly fluid, partly clotted, was disclosed, extending from the diaphragm above to the iliac fossa below, and situated retroperitoneally. The peritoneum overlying this area was bruised and of a dark color in parts, but was not actually torn through; it could be lifted off the underlying mass of blood clot without tearing it.

The clot was removed from the loin without creating new hemorrhage, and the kidney was thus exposed. It was found to be torn in two; the ureter and lower half of the organ were not seen at any time during the operation. The upper half of the kidney was attached to the aorta by the renal artery. The renal vein had been torn across and a thrombus occluded its lumen. The renal vessels were clamped (the clamp was left *in situ* and removed on the third day), divided outside the clamp, and the kidney was removed. No ligatures were applied to the vessels. The patient made a rapid recovery.

Intraperitoneal Hemorrhage from Lacerated Liver and Kidney, Controlled by Packing.—11. (Bardenheur.) A young man was run over by a heavy team. Severe shock and intraperitoneal hemorrhage followed the injury, and a large tumor in the loin formed soon after the accident.

Operation.—Laparotomy. Profuse intraperitoneal hemorrhage was found proceeding from the right kidney through a rent in the overlying peritoneum and from an extensive rent in the liver. Nephrectomy was performed, and the laceration in the liver was packed with sterile gauze. Recovery. Patient discharged well at end of two months.

SPONTANEOUS ARREST OF HEMORRHAGE FROM THE KIDNEY.—12. (Waldvogel.) A case in which recovery followed suture of a wound of the ascending colon which had been produced by the same accident which ruptured the right kidney. The kidney was not disturbed at the time of the operation. An extensive hemorrhage which had taken place from the wounded kidney was spontaneously arrested. Recovery followed, without further intervention than that which was done for the injured bowel.

13. (Guinard.) This case is another illustration of the spontaneous arrest of hemorrhage.

The injury was inflicted upon the anterior abdominal wall. The early symptoms were vomiting and pain. There were no *constitutional* evidences of serious hemorrhage at first, but a large tumor formed in the loin of the injured side. On the eighteenth day there appeared the general signs of hemorrhage. Abdominal nephrectomy was done. The renal artery was found to be torn across; there was an immense retroperitoneal hematoma, but the bleeding had been, at first, arrested spontaneously. Recovery followed the operation.

SUBPARIETAL INJURIES OF THE URETER.

Subparietal lacerations of the ureters are of rare occurrence. When the accident takes place, it is generally associated with the same injury to the kidney.

Morris[16] says that but 3 out of 24 cases of reported laceration of the ureter collected by him could be proved to be such. He refers to a case reported by Poland,[17] which was that of a woman who was caught between a railway carriage and a platform, and whose right ureter was torn across just below the pelvis of the kidney. The kidney was also ruptured.

Nicolich[18] reports another instance which he considers to have been a rupture of the ureter caused by a blow in the region of the left kidney. A tumor formed a month later, from which urine was withdrawn by the aspirator. There was no positive proof in this instance that the ureter was implicated.

Etiology.—The same as that of subparietal injury of the kidney, except that it has not, so far as we are aware, been produced by muscular action alone, as the laceration of the kidney has been.

Tuffier thinks that the injury to the ureter is caused by its being crushed against the transverse process of the first lumbar vertebra, while Fenger considers it to be due to an overstretching of the ureter.

Symptoms and Diagnosis.—When the injury of the ureter alone occurs, the symptoms may be very obscure for a time. When the kidney is also lacerated, the renal symptoms usually conceal those which are due to the laceration of the ureter.

When there is no lesion of the kidney, hematuria will be slight or absent. The characteristic feature by which it is possible to recognize the ureteral laceration is the appearance of a tumor in the loin, not immediately, but at some time after the receipt of the injury. This tumor will always form, unless the secretory function of the kidney has been suppressed.

Its appearance may be delayed for days, and even for weeks, as is shown by the cases reported by Allingham,[19] by Page,[20] by Barker,[21] and by Hicks,[22] in which it did not form until the following times after the injury: seven days, fourteen days, fourteen days, and twenty-one days.

Aspiration of the swelling is usually required to determine the nature of the tumor.

Infection will almost inevitably take place in the extravasated urine, and will give rise to perinephritic abscess. This will be announced by the occurrence of the symptoms which characterize the conditions which are presented in detail in the chapter on Suppurative Conditions of the Kidney.

Treatment.—When the diagnosis is established there can be no doubt as to the necessity of prompt operation. The factor which should determine surgical intervention is the finding of a collection of urine, or urine and blood, in the retroperitoneal space.

We do not believe in palliative measures under these conditions, despite the fact that one or two recoveries and cures have followed aspiration of the collection of urine. The chances are far too great against the probability of having this happen in any given case, to make it a desirable method of treatment; whereas every advantage—including the greater safety of the patient—is to be gained by an open incision, which affords the opportunity to restore the continuity of the severed or wounded ureter or renal pelvis. It is not *always* possible to accomplish this by exposing the ureter, but it is the only way in which any chance is offered of so doing.

Unless an intraperitoneal organ is injured in association with the laceration of the ureter, the operation should always be an extraperitoneal one. When the contrary is the case, the operation should be one

which opens the abdominal cavity. In either case, the incision should be one which exposes the ureter, or which can be made to do so by extending it.

The best method of approach, in the writer's opinion, in the cases in which the peritoneum is not implicated in the injury, is through the loin, by the incision which starts at the tip of the twelfth rib and passes downward in front of the anterior superior spine of the ilium to a little above the middle of Poupart's ligament. The peritoneum can be carried toward the median line and the ureter freely exposed extraperitoneally.

If the condition of the patient and the position of the wound of the ureter make it possible, the latter should be closed by suture, or its severed ends united by one or another of the methods of making an anastomosis.

If the kidney is extensively injured, or if the injured ureter cannot be repaired, nephrectomy is the operation to be chosen, unless the wound of the ureter is such as to allow a reasonable hope of its spontaneous healing and restoration of the continuity of the canal.

Drainage through the loin and closure of all the rest of the incision are steps that should be taken to complete the operation.

When nephrectomy has not been done, and lumbar drainage has been chosen in its stead, and if a urinary fistula persists subsequently, as it is very likely to do, a secondary operation may be undertaken, or not, according to the condition of the patient, and the amount of distress caused by the urinary fistula.

If it is found at the time of the secondary operation that the opening into the ureter cannot be repaired, and if the opposite kidney is known to be functionally capable, nephrectomy should be performed.

When infection and suppuration have taken place in the retroperitoneal space, lumbar drainage should be instituted and attempts to close the wound in the ureter, or to join its severed ends together again, had better be postponed until the patient's condition, both local and general, has so far improved as to make success more probable than would be the case were the operation to be performed in the first instance.

PENETRATING WOUNDS OF THE URETER.

The ureters are occasionally injured as the result of penetrating bullet or stab wounds. There are a few cases of such injuries published. Morris[16] has been able to find but two instances of bullet and three of stab wounds of the ureter recorded. Poland[17] has reported two cases of gunshot wounds of the ureter, one of which was that of the Archbishop

of Paris, who died eighteen hours after receiving the injury. A post-mortem examination showed that the left ureter had been divided close to the renal pelvis.

Accidental or necessary wounding of the ureter has occurred in the course of a good many abdominal operations.

Gunshot and stab wounds of the ureter are very apt to involve the renal bloodvessels and the peritoneum or intraperitoneal organs.

Treatment.—Except for that which is directed to the associated complications noted just above, the treatment is the same as that already outlined in connection with subparietal injuries of the ureter. No general rules with relation to the treatment of the complications that may be present can be laid down. Each case will have to be treated surgically in accordance with the special indications which are presented. The only general statement that can be made is that the greater the probability of intraperitoneal involvement, or of injury to the bloodvessels of the kidney, the more imperatively is surgical intervention demanded for the purpose of repairing wounds of the intestine, liver, or other intraperitoneal structure, and to avert peritonitis, or to arrest hemorrhage from wounded bloodvessels of the mesentery or of the kidney.

There are various ways of dealing with wounds of the ureter which are accidentally made in the course of intra-abdominal operations. Here, again, every case must be treated in whatever way is indicated by the special circumstances attaching to it. The following principles will be found to cover the ground in almost all conditions that are likely to be encountered.

1. Except as a last resource, the kidney to which the injured ureter belongs should not be sacrificed by nephrectomy.

2. Whenever the continuity of the injured ureter can be restored, this should be done by making an anastomosis between its divided ends.

3. When this is not possible, the best method of treating the injured ureter is by implanting into the bladder the divided end of the part of it which leads from the kidney.

4. When it is impossible to carry out the procedures noted in the second and third of these ways, bring the divided end of the upper part of the ureter to the surface and attach it there in whatever place it can be most conveniently and best placed, in order to secure free drainage of the kidney through it. If the resulting urinary fistula causes such distress to the patient as to necessitate a secondary nephrectomy, that operation can be done at an appropriate later time.

The step of bringing the end of the ureter to the surface is better than to abandon it in the operative field or than to implant it into the bowel.

5. In the few cases in which it can be done, and in which the anastomosis with its own canal cannot be accomplished, it may be possible to unite the end of the upper segment of the ureter with the ureter of the opposite side.

In addition to the above means of disposing of the end of the wounded ureter, the following methods are mentioned by Morris:

Bringing down the kidney and fixing it at the level of the iliac crest (Bovée).

Attaching the two ends of the severed ureter to the edges of the wound and joining them together later.

Establishing a continuous channel between the divided and separated ends of the ureter—when they cannot be brought together at the time of the receipt of the injury—by making a channel of skin between them (Rydygier). The same object may be gained by employing the peritoneum of the posterior surface of the bladder, or a piece of the bladder wall itself, and without having previously stitched together the ends of the ureter (Van Hook).

When the ureter is wounded and the fact is not recognized, and, in consequence, urine leaks into the abdominal cavity, peritonitis will result sooner or later.

The data from which the tables and calculations in the chapter on Subparietal Injuries of the Kidney and Ureter have been made are derived from an article published by Watson in the *Boston Medical and Surgical Journal*, July 9, 1903, and include the following compilations, reported cases, and writings, as well as numerous other individual series of cases not named.

Delbet's[12] article of 1901, which contained a summary of 320 cases, and in which were included the compilations published by Maas, Grawitz, Bloch, Obalinsky, Wallis, and almost all of the cases reported by Küster, Tuffier, and Wagner previous to 1901. Delbet's article also contained references to the theses of Foy, Moser, Ravel, Martin, Poireault, Gargam, Sladowski, Péan, Pfeiffer, and Bidault.

To these cases of Delbet, which numbered 320, Watson added 340, making a total of the series in his article of 660.

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CHAPTER XXIII.

HYDRONEPHROSIS OR URONEPHROSIS.

Synonym.—Sackniere.

Definition.—Distention of the renal pelvis, calices, the renal substance—one or all of them—by pressure of retained aseptic urine, this retention being due to an obstacle to the free escape of the renal secretion through the natural channels.

Bilateral Hydronephrosis.—Frequency.—The following figures will give an idea of the frequency of bilateral hydronephrosis: Küster found 32 bilateral hydronephroses in a total number of 492 cases of the affection. Newman found 448 cases of bilateral hydronephrosis in a total number of 665 which he collected from the literature. Morris says that in 381 cases of the malady, 274 were recorded as bilateral.

Etiology.—Anything which prevents the free escape of the urine from the kidney may result in hydronephrosis. Complete, total, long-continued or permanent obstruction of the ureter does not cause hydronephrosis. In order to have it produced, the obstruction, if complete, must be repeated and short-lived; or, if partial, it must be repeated, long-continued, or permanent.

The nearer the obstruction is to the renal pelvis, the sooner will it produce hydronephrosis; thus partial closure of the ureter will bring it about more rapidly than will such an obstacle as prostatic hypertrophy or urethral stricture.

The causal factors are, generally speaking, of two sorts:

1. *Congenital anomalies* of the ureters, such as to offer obstacles to the escape of urine from the kidney. 2. *Acquired conditions* of the ureters, which have the same result.

In the first of these classes are included: Absence of the ureters, single ureter and multiple ureters, abnormal positions of the orifices, bends or twists, narrowings, and valves of the ureters, and imperforate ureters. There may also be included narrowings caused by the pressure exercised upon the renal pelvis or ureter by abnormally placed branches of the renal bloodvessels.

The acquired forms may be brought about by *twists*, *kinks*, or *bends* of the ureters, such as occur in connection with *movable kidneys* or kidneys which have become *fixed in abnormal positions;* by *pressure* upon the ureter *from without, as by tumors* of adjacent organs, or *by adhesions* which are formed about the renal pelvis or the ureter;

by obstacles to the free escape of urine from the kidney, placed in the outlet of the renal pelvis or in the *course of the ureter*, such as *stricture and calculus;* and, again, by more remote *obstruction* to the outflow of urine, such as is produced *by vesical tumors* situated close to the ureteral orifice in the bladder, and by the *enlarged prostate*, and *by urethral stricture.*

FIG. 357

Bilateral congenital hydronephrosis, distended bladder, and ureter. From congenital stricture of the urethra. (Warren Museum.)

1. CONGENITAL FORMS.—Examples of congenital *stricture of the urethra* producing hydronephrosis have been recorded, among others, by the following: Duval and Gregoire,[1] Keyes,[2] and Morris.[3]

Fig. 357 illustrates bilateral congenital hydronephrosis. The illustration is taken from a photograph of a specimen in the Warren Museum of the Harvard Medical School. It shows an enormously distended bladder, ureters, and bilateral hydronephrosis, due to congenital stricture of the urethra.

Absence of the Ureter.—In some cases the ureter is wholly obliterated; in others, it is totally occluded for part of its course. Absence of the

ureteral canal as a cause of hydronephrosis is not in accord with our knowledge of the manner in which hydronephrosis is produced, it being due, it is believed, to repeated short-lived total obstruction of the canal or to partial, long-continued obstruction of it, not to total permanent occlusion.

Morris[3] states that probably one-third of the cases in which tumor can be felt are of congenital origin, and quotes Roberts as having found congenital malformation, of one sort or another, of the kidney, ureter, or renal artery in 20 out of 52 cases.

Single Ureter and Multiple Ureters.—It is difficult to see why these conditions should cause hydronephrosis, unless other anomalies co-exist which are productive of obstruction in the course of the ureter or at its orifice. Such associated abnormalities of conformation are frequent in ureters which present anomalies of number.

Changes in the Vesical Orifices of the Ureters.—In a certain number of cases the lower end of the ureter is abnormal y placed: in the rectum, the prostatic urethra, and, again, upon some part of the bladder other than its normal position. The orifices of ureters which are thus malposed are apt to exhibit anomalous conditions of form or caliber, and hydronephrosis may result when they are abnormally narrow.

Walter, Meigert, Palmer, Thiersch, and Hoffmann have reported cases of abnormally placed lower ends of the ureters, in all of which the orifices were more or less narrowed, and in all of them hydronephrosis had been produced as a result of this condition.

Pressure upon the Ureter or the Renal Pelvis by Abnormal Renal Bloodvessels.—In a certain number of the cases of congenital hydronephrosis, the etiological factor has been an aberrant renal bloodvessel, which was so placed as to cause partial obstruction to the outflow of the urine from the kidney. Morris[3] refers to two of the congenital cases reported by Roberts[5] as being due to this cause. Keyes[6] says that this is a common cause of the condition, and gives an excellent illustration of it. Morris has two cases in his work on *Surgical Diseases of the Kidney and Ureter.*

Valves, twists, kinks, and stricture of the ureter and abnormal position of the renal end of the ureter or renal pelvis are all causes of congenital hydronephrosis, and among the most frequent of them. In cases of congenital stricture, the portion of the canal lying above the narrowing may be widely dilated and the renal pelvis and kidney may not share in the distention. An instance of this is reported by Morris.[7]

Phimosis and congenital stricture of the urethra are also occasional causes of renal distention.

2. Acquired Hydronephrosis.—*From Movable Kidney.*—The frequency of the causal relation between movable kidney and hydronephrosis

has been a much discussed subject, with regard to which divergent views are held. Tuffier attributed a very important role to the abnormal mobility of the organ in the production of the renal condition. As the result of experiments with animals, Hildebrand and Haga arrived at the following conclusions with regard to the matter: (1) That sharp bends in the ureter cause hydronephrosis. (2) That the production of an abnormal mobility, experimentally, does not lead to hydronephrosis, even when this mobility has been present for long periods. (3) That even long-continued mobility of the kidney which produces complete twists of the ureter does not produce hydronephrosis. (4) That movable kidney causes hydronephrosis only when it brings about a very marked obstruction in the course of the ureter, and that this obstruction does not take place when the ureter is curved merely, but that it must be very sharply bent.

Other observers have maintained that abnormal mobility of the organ per se is not sufficient to create hydronephrosis, and that, in the cases in which it has been thought to do so, some narrowing or abnormal position of the orifices of the ureters have existed and been overlooked. That this is true of a certain proportion of the cases that have been reported we may well believe, but that movable kidney *never* causes hydronephrosis *is not true*, in our opinion, for such a view is wholly at variance with our personal observations upon the living subject and upon the cadaver as well. It appears, however, that the proportion of cases in which movable kidney gives rise to the renal distention is small. One of the reasons for attributing so large a number of the cases to the renal mobility was doubtless the failure to recognize that hydronephrosis not infrequently is, in itself, an etiological factor of movable kidney. Bazy has recently urged this view.

As the Result of Pressure from Adhesions upon the Renal Pelvis or Ureter.—That this is not a more frequent cause of hydronephrosis is rather surprising, since one would naturally think that a sufficient degree of pressure to create it would be exercised by the oftentimes dense masses of connective tissue formed about the renal pelvis and upper end of the ureter in connection with intrarenal inflammatory, tuberculous, and other conditions, as one result of which they are so frequently encountered. (See Illustrative Cases, No. 1)

Renal Calculus.—The obstruction produced by the partial blocking of the ureteral canal or its orifices by calculus is one of the common etiological factors of hydronephrosis.

In an analysis of 142 cases of hydronephrosis by Morris,[8] the following conditions are given as the causal factors: external pressure in 116; this was caused by cancer of the uterus, vagina, bladder, or rectum; in

2 others by cancer of the ovary. In the 24 remaining cases the causes were as follows: unknown, 4; cystitis, 3; vesical calculus, 3; tumor of the bladder, 1; enlarged prostate, 3; ovarian cyst, 4; cancer of abdominal organs, 3; constriction of ureter, 3.

Occasionally true hydronephrosis results from trauma of the kidney and, more frequently, from injury or wounds of the ureter, which later result in stricture of its canal.

Pseudohydronephrosis, which sometimes occurs as a consequence of renal injuries, is difficult to distinguish from the true distention of the kidney, from which, however, it is very different. It represents a collection of urine external to the kidney (with the interior of which it may communicate), hemmed in by adhesions.

Pathology.—As was mentioned at the beginning of this section, total occlusion of the ureter, unless it be maintained for short periods only, and unless repeated, does not produce more than a very slight degree of distention of the renal pelvis and calices. If complete, long-continued, or permanent occlusion of the ureter is produced, the following phenomena are observed:

1. Increased intrarenal pressure.

2. Congestion and œdema of the kidney and its consequent enlargement.

3. Rapid diminution of the urine and change in its chemical character, the latter consisting in a marked reduction of the solid constituents. This becomes obvious at the end of an hour after the occlusion of the ureteral canal has taken place. The urinary secretion is almost wholly suppressed in the course of a few hours. After four or five hours, but a few drops in the course of each day are added to what is already contained in the renal pelvis. This slight increase is, however, maintained for a few days at any rate, and, in this way, moderate hydronephrosis, which is almost always limited to the renal pelvis, but sometimes involves the calices in a moderate degree, is brought about. The enlargement of the kidney which is noticed in the early phases of the condition is due not to an intrarenal collection of fluid, but to congestion or œdema.

4. Within twenty-four to forty-eight hours destructive changes of the secreting substance of the kidney begin, and if the free outflow of the urine from it is not restored, total destruction of the organ ultimately results.

Total Occlusion of Ureter.—In some instances a total occlusion of the ureter supervenes upon one that has been partial and from which hydronephrosis has resulted. That is to say, a closed hydronephrosis, as it is termed, has been engrafted upon an open one. The occurrence is fraught with graver danger with respect to the destruction of the

secreting elements of the organ than when the ureteral occlusion takes place in connection with a kidney not already hydronephrotic, because of the fact that there is just so much less secreting substance in the diseased organ to be destroyed than in the one which is not diseased.

Partial Occlusion of the Ureter.—Partial or repeated occlusions of the ureter, of short duration, are the conditions that are particularly prone to cause hydronephrosis. This is owing to the fact that the kidney does not cease to secrete urine in considerable quantities, while, at the same time, there is brought about by the obstruction to its free outflow from the kidney an increased intrarenal pressure which ultimately causes, first, distention of the renal pelvis and calices, and, later, atrophy of the renal substance itself. This atrophy will be more or less, and will be steadily or irregularly progressive, according to whether the obstruction of the ureter narrows its caliber much or little, and according to whether or not the conditions are such as to allow the distended kidney to empty its retained collection of fluid periodically.

Recently, Duval and Gregoire[1] have denied the existence (except in the clinical sense, as manifested by symptoms) of hydronephrosis which is intermittent, structurally speaking. They assert that hydronephrosis is necessarily a constant lesion, and not one which varies intermittently. The intermittent character of the symptoms is due to more or less frequently repeated acute and complete retentions in the course of chronic hydronephrosis, the latter condition being often overlooked.

The Changes in the Renal Tissue.—In the hydronephroses of the more extensive sort, which, as we have seen, are brought about by partial obstruction of the ureters, or by the back pressure caused by the more remotely placed obstruction which is produced by prostatic hypertrophy or stricture of the urethra, the structural changes first noticed are those which are due to interference with the capillary bloodvessels of the kidney, beginning in the papillæ and gradually extending farther toward the exterior of the organ, and brought about by the back pressure exerted upon the parts by the retained urine. Hand in hand with these changes a gradually progressive anemia of the kidney takes place.

Under the influence of the back pressure the renal pelvis and calices become distended. When this has reached a certain point, atrophy of the renal substance begins. This is manifested at first by a flattening of the papillæ, which later, as the atrophy proceeds, lose their form, and can no longer be recognized. Next in order, the renal parenchyma becomes involved in the same process and is slowly destroyed (Figs. 358, 359, and 360).

Wagner[9] quotes Ayer,[10] who showed, from a series of observations, that the total disappearance of kidney tissue in hydronephrosis is of very

rare occurrence. Ayer found but 11 such instances in 473 cases of hydronephrosis examined by him.

The most interesting and the most practically important point in this connection is the degree of functional capability retained by such renal substance as remains in cases of hydronephrosis. Albarran[11] urged the importance of recognizing the fact that it was impossible to form an estimate of the degree of functional capability by inspection of such kidneys at the time of operation; that it often happens that hydro-

Fig. 358

Hydronephrotic kidney. External surface.

nephrotic kidneys in which a seemingly wholly inadequate amount of renal substance exists, nevertheless were found to be capable, when relieved of the pressure of the retained urine, of resuming a useful degree of functional activity. He furthermore pointed out that the only means by which this could be established, one way or another, was by examinations of the urines passed from such kidneys subsequent to their being incised and delivered of their contents, and then only after the lapse of considerable periods of time, since it has been demonstrated that the urine secreted *immediately* after the laying open of such a

kidney, and for some time afterward does not represent the functional work of which the organ later becomes capable.

The theory which was put forward at one time by Landau, that there occurred an actual regeneration of the kidney substance in cases of hydronephrosis after free exit had been given to the urine, was subsequently disproved, but that the functional capability of such kidney substance as remains does increase for considerable periods after the urinary flow has been reëstablished, there is no doubt.

Fig. 359

Hydronephrotic kidney. Same case as Fig. 358; view of inside of kidney.

The other structural change which takes place in addition to the atrophic ones already mentioned is that of a proliferation of the interstitial connective tissue which results in general sclerosis of the organ, of greater or less extent.

The urine of hydronephrotic kidneys, as a rule, has albumin and crystals of uric acid and oxalate of lime. It is of low specific gravity, and is usually of alkaline or neutral reaction. Casts are often absent.

In a small proportion of the cases hydronephrosis involves but one part of the organ, and such have been reported by Morris,[8] by Fenger,[12] and others. Morris refers to a case reported by Fugel in which a great distention of one calyx alone was believed to be an intraperitoneal tumor.

Symptoms and Diagnosis.—*Tumor.*—The existence of hydronephrosis of moderate degree, even if bilateral, is often overlooked, owing to the fact that it may give rise to no symptoms of sufficient importance to attract the attention of the patient. In the more advanced stages of the condition the characteristic symptom is, of course, the presence of a tumor in the loin. Morris says that in but 25 out of 42 cases could a tumor be made out.

The characteristics of the tumor when present are: dulness on percussion, upward and downward movements corresponding to those of the diaphragm. In cases in which the tumor attains large size, the colon

FIG. 360

Hydronephrotic sac. Renal substance wholly destroyed.

and the intestines are usually displaced. In those in which it is of moderate dimensions, and the colon lies in front of it, the percussion note over the anterior surface of the tumor will be resonant or tympanitic. Sometimes the lobulated character of the tumor is recognizable and fluctuation is readily made out in the hydronephroses of large size. Aspiration with a fine needle passed into the tumor through a part over which there is a dulness on percussion aids in establishing the diagnosis.

Pain is not present in the cases of hydronephrosis of moderate extent unless abnormal mobility of the kidney, or its fixation in an abnormal

position by adhesions which constrict the organ as it increases in size co-exist with it. When these conditions are present, severe and disabling pain may occur with very moderate degrees of hydronephrotic distention.

In the more pronounced examples of the condition, pain usually is a constant symptom.

In the intermittent form, alternating appearance and disappearance of the tumor and coincident recurrence of pain and freedom from it are characteristic features.

Uremic symptoms in connection with bilateral hydronephrosis especially may be the only ones that are noticeable.

In the intermittent form, the subsidence of the tumor will be accompanied by the sudden discharge of more or less urine from the kidney into the bladder, and a succeeding period of polyuria. This symptom may be present, however, in cases of movable kidney in which hydronephrosis does not exist.

Ureteral catheterization may be of much assistance in making the diagnosis, by withdrawing from the affected kidney, in unilateral cases, a urine of characteristic quality and contrasting conspicuously with that secreted by its fellow.

Except in connection with calculus, hematuria is rarely seen in cases of hydronephrosis. Morris refers to its being present sometimes, and mentions a case of his own and others of Allingham, Israel, Reclus, and Albarran in which it was a symptom.

The conditions with which hydronephrosis may be confused are pyonephrosis, perinephritic abscess, hydatid cyst of the liver or of the kidney, ovarian tumor, especially if it has a long pedicle; cystic disease of the kidney, and distended gall-bladder.

It is usually readily distinguished from pyonephrosis by the fact of the absence of temperature and of other characteristic systemic evidences which occur in the latter condition. The absence of pus in the urine in cases of hydronephrosis will also serve to distinguish it.

Unless the tumor of the ovary be a large one, the position which such a growth occupies is much lower down in the abdomen than is the case with the hydronephrotic kidney, and bimanual examination will serve to discriminate the ovarian from the renal tumor. The ovarian tumors with long pedicles are much more freely movable than hydronephrosis in most instances.

The tumor caused by hydatid cyst of the liver or spleen and a distended gall-bladder are, except in cases of very extensive hydronephroses, much more prominent anteriorly and much closer to the front of the abdominal wall than is the case with the renal tumor. It is, however,

only by aspiration of the swelling that we can determine, in some instances, which of these three conditions exists, and this is still more true of the differential diagnosis between hydronephrosis and hydatid cyst of the kidney.

Treatment.—Medical treatment has no place in cases of hydronephrosis. The chief principle to be observed in the surgical treatment is that of employing one or another of the conservative operations, whenever possible; that is to say, to withhold nephrectomy, except as a last resource, to be practised only in the cases in which it is perfectly evident that there is no useful degree of functional activity remaining in the distended kidney, and in which it has been demonstrated that the other kidney is functionally capable, and to devote the attention to the correction of malpositions of the kidney, of the renal pelvis, and ureters, and to removing from them obstacles to the free escape of the urine from the kidney when it can be done. Such other obstacles as are more remotely placed—urethral stricture, prostatic enlargements, or tumors of the bladder situated at or near the vesical orifices of the ureteral canals—should also be overcome.

These ends should be sought in all cases in which it is possible to secure their accomplishment. In those in which, because of the inherent difficulties involved in their practical execution, or because the general condition of the patient makes it impossible, nephrotomy, followed by secondary nephrectomy, if appropriate, are the measures to which recourse must be had.

Aspiration has, it is true, brought about the permanent disappearance of hydronephrotic tumors in a few cases, but it has wholly failed to do so in many others, and is not a procedure which commends itself, except in doubtful cases, for purposes of diagnosis.

When hydronephrosis is extensive, aspiration, after the kidney has been exposed in the loin, should be done, in order to allow the operator to inform himself of the exact nature of the condition to which the obstruction to the urinary outflow is due, which cannot be determined, as a rule, so long as the distended organ obscures the field.

Nephrotomy, although to be avoided as the *sole* procedure, if possible, is necessary as an exploratory step in many cases, for without it it will be impossible to determine whether or not there is enough renal substance remaining to carry on a useful degree of functional work. In some cases it will be the only operation that the conditions permit. This will be true whenever the cause of the obstruction cannot be so dealt with as to afford a free outlet in the future to the retained urine through the natural channels, and thus prevent the recurrence of the condition which was originally responsible for the production of the

hydronephrosis; that is to say, if we are not reasonably assured that we can overcome the obstacle by correcting a malposition of the kidney, renal pelvis, or ureter, by removing a calculus which is lodged in the course of its canal, by doing a prostatectomy, or taking away a tumor of the bladder, whichever of them may be the cause of the hydronephrosis, we must rest content with nephrotomy, supplementing it later, perhaps, by a secondary nephrectomy; or else we must do a primary nephrectomy should none of the contra-indications to its performance be present.

Avenue of Approach to the Kidney.—All cases of hydronephrosis are, we believe, best approached through the loin. The single lumbar incision can always be supplemented by a second one, when more space is needed.

If the kidney is incised and drained the separate pouches which afford lodgement for collections of urine thould be thrown into one chamber, in order to secure thorough drainage.

If the ureter must be exposed for the purpose of correcting some condition connected with it which is obstructing the outflow of urine from the kidney, the original lumbar incision will have to be extended in order to accomplish this. (See chapter on Technique of Operations on the Kidney.)

Nephropexy.—When an abnormal degree of mobility of the kidney is the etiological factor of the hydronephrosis the operation of nephropexy will in many instances permanently overcome the difficulty and prevent its recurrence.

Division of Bands Constricting the Ureter, Renal Pelvis, or Kidney.—When peri-ureteral adhesions, or bands constricting the renal pelvis, are present, their division may be sufficient to restore the free outflow of the urine, and this operation will be all that is demanded. In other cases, the kidney itself is traversed by constricting bands. These may be so dense and may so intimately unite the organ with adjacent parts, or be so closely connected with the kidney itself, that their separation cannot be accomplished without injuring the organ. They may also fix the kidney in an abnormal position, and thus produce an obstruction to the urinary outflow from it, and may be too dense to allow the malposition of the organ to be remedied.

Ligature and Section of an Aberrant Renal Artery or Branch of the Renal Artery.—Ligature of a branch of the renal artery itself results in partial necrosis of the kidney, which occurred in a case reported by Helferich. It is an open question if the ligature and division of an aberrant bloodvessel causing obstruction to the urinary outflow will remedy the hydronephrosis. In the cases in which this *has* been done it has almost always been combined with the operation of nephropexy,

to which the success of the operative intervention may very probably be referred. Ligature and division of such an aberrant vessel per se results, it is said, in no improvement of the existing conditions.

Drainage by Ureteral Catheter.—This procedure, which has been urged by a few surgeons, has failed to establish a claim to serious consideration, and we do not include it in the discussion of the surgical methods of treatment.

Operative Results.

		Cases.	Deaths.	Mortality (p. c.).
Nephrectomy:				
Primary	Collected by Schmieden	97	20	20.6
Secondary	Collected by Schmieden	27	3	11.1
		124	23	

In 66 nephrectomies done between 1890 and 1900 there were but 5.7 per cent. operative mortality.

	Cases.	Deaths.	Mortality (p. c.).	Fistula.	Without fistula.
Lumbar nephrotomy:					
Collected by Küster[13]	138	10	7.2	76	52
Collected by Watson[14]	143	5	3.4		

Conservative Operations.—Duval and Gregoire[1] give the result in 56 operations of various kinds of the following character:

Section of spur at junction of renal pelvis and ureter, 13 cases; no deaths; 2 secondary nephrectomies and 1 fistula.

Ureteropyeloplastics, 17 cases; no deaths; 5 failures.

Pyeloplication, 8 cases; no deaths; 1 failure.

Resection of renal pelvis, 3 cases; no deaths.

Anastomosis of renal pelvis and ureter, 12 cases; 1 death; 4 failures.

Ureterolysorthrosis, 1 case; no deaths.

Pyelovesical anastomosis, 2 cases; no deaths.

Summary.—56 cases; 2 deaths; 3.6 per cent.; failure, 13 (23.4 per cent.).

Fistula resulted in 5 cases.

Kidney remained distended in 3 cases.

Partial necrosis of the kidney, 1.

Obliteration of the mouth of the renal pelvis, 1

Ureteral caliber too narrow to give exit to urine, 1.

Late Results

PERMANENT CURES.

Fenger	6 years	(ureteropyeloplasty).
Bardenheuer	15 months	"
Bazy	15 "	"
Richardson	10 "	"
Israel	12 "	(pyeloplication).
Bazy	7 years	(ureteropyeloneostomy).
Legueu	1 year	(ureteropyeloneostomy).

Illustrative Cases.

Case I.—*Hydronephrosis Produced by Pressure of Bands of Adhesions upon the Renal Pelvis and Ureter.*—A man, aged forty years, who twenty years before had received an injury to the right side. One rib was probably broken at the time. After the first forty-eight hours the patient experienced no special discomfort, and noticed no symptoms referable to the injury for six or eight years after the accident. He then began to have attacks of pain located about midway between the crest of the ilium and the free border of the ribs on the right side. At first these were of rare occurrence, but, little by little, they became more frequent and of greater severity. During the past year he has been occasionally temporarily disabled by the pain.

Operation.—At the time of the patient's first visit he was suffering from a moderate degree of dull pain, which was rather indefinitely located in the right side of the abdomen. There was moderate tenderness on pressure over the region of the appendix and over that of the right kidney, but it was more noticeable in the linea semilunaris, about one-third of the way in its course, from the lower border of the ribs. At this point there was also a sense of increased resistance, but no definite tumor could be made out. The urine was normal.

The pain became more intense a day or two later, and exploratory laparotomy was advised.

The abdomen was opened by an incision through the linea semilunaris. Examination through this incision revealed a tumor somewhat larger than the closed fist, which proved to be the right kidney, the pelvis of which was greatly distended and the calices moderately so, the distention—hydronephrosis—being due to several dense bands of adhesions, which passed across the anterior surface of the kidney and its pedicle, and some of which had prevented the free escape of urine from the organ. The kidney was in an abnormal position, it having been dis-

placed downward, so that its hilum was on a level with the umbilicus, and it was pressed firmly upon the lateral aspect of the bodies of the vertebræ.

It was found to be impossible to liberate the kidney from its position and to restore it to its normal place, and nephrectomy was done as the only resource.

The patient did well for the first twelve days after the operation, then developed a septic pneumonia and died on the fourteenth day.

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are found to be associated with the graver pathological changes that occur in the kidneys in connection with the pus-producing infections.

Renal infections are occasionally seen in connection with pneumonia and typhoid. The pneumococcus and typhoid bacillus are found in the urine in these cases.

The chief role played by the gonococcus seems to be that of preparing the ground to receive the attacks of other microörganisms by weakening its resistance to their invasion rather than that of assuming the chief part. It is but rarely found in these cases. The following observers have reported instances of its presence: Bransford Lewis, Gerster, Bockhart, Ravogli, Rendu, Coats, Carlslaw, Wladimirsky.

With the exception of the case reported by Bransford Lewis, all have been examples of mixed infections; in his the gonococcus alone was found.

Manner of Invasion.—This takes place in one of two ways: (1) Ascending, from infective processes of the lower parts of the genito-urinary tract. (2) Hematogenous.

Ascending Infection.—The bladder is usually the starting point of an ascending renal infection. The renal pelvis is then always infected before the kidney, but in acute cases it is clinically impossible to define the moment at which the process passes from the renal pelvis to the renal substance itself.

Hematogenous Infection.—Infection by the blood current may be carried to the kidney from more or less remote foci of similar nature anywhere in the body. It has been known to start from such sources as carbuncle, abscess of the tonsil, from a suppurative process in the parotid gland.

The point of entrance of the infection which ultimately reaches the kidney may be anything from a scratch or abrasion to a deep wound on the surface of the body.

The systemic diseases with which renal infections are more commonly associated are: general septicemia or pyemia; less often they take place in connection with typhoid fever, pneumonia, scarlet fever, and dysentery. Infection of the kidney is frequent in cases of *traumatic* lesions of the organ.

Anything which obstructs the free escape of the urine from the kidney invites infection. It is often engrafted upon hydronephrotic kidneys, and is then known by the name of *pyonephrosis*.

Pathology.—Suppurative processes in the kidney may be placed under two general headings: (1) Diffuse. (2) Collections of pus representing abscesses of greater or less size. The term surgical kidney is often given to the latter of these. It is confusing and should be abandoned.

DIFFUSE SUPPURATION.—This term is applied to suppuration which is disseminated through the kidney in the form of small separate foci of pus surrounded by areas of congestion. Microscopic examination of the central portions of these collections of matter shows quantities of bacteria. Infection of this kind is conveyed to the kidney by the *blood current*, and the small collections of pus found scattered through the renal parenchyma, in many instances, originate in minute emboli which become lodged in the finer capillary bloodvessels of the organ. The individual foci of pus may become confluent as the disease progresses and so create abscesses. This is the condition to which the name *suppurative nephritis* is properly applied.

In the *ascending infection* there may also be diffuse suppuration as above described, but here it will always be combined with a primary purulent process of the renal pelvis, and becomes a *pyelonephritis* of suppurative character. Again, the renal pelvis may be *secondarily* involved, the renal parenchyma having been primarily infected through the blood current and the renal pelvis becoming *later* infected by extension of the original condition to it.

Relative Frequency of Unilateral and Bilateral Renal Suppuration.—There is a diversity of opinion with regard to the relative frequency of the unilateral and bilateral acute hematogenous renal infections or suppurative nephritis.

This contradictory view is seen in such statements as the following: "In hematogenous infections the condition is usually bilateral, though embolic infection may occur in but one kidney" (White and Martin[3]).

"Suppurative nephritis is usually unilateral" (Keyes[4]).

"In the hematogenous form of acute suppurative nephritis, small miliary abscesses form in the kidneys, seldom becoming sufficiently confluent to make an abscess of more than very moderate size. This form of infection is almost always bilateral" (Frisch and Zuckerkandl[2]).

The infection was bilateral in the large majority of 51 postmortem examinations referred to by Morris.[5]

"Cases of large abscess of the kidney which results from confluence of numerous small miliary abscesses of the kidney, whether the latter originate in an ascending or hematogenous infection, may be limited to one kidney, the other being quite unaffected" (Morris[5]).

The frequency of unilateral renal infection, or the frequency with which one kidney alone is at first implicated, has not been realized until recently. The postmortem observations do not afford us the opportunity of estimating its occurrence correctly, since at the time of death both kidneys are often involved in an infection which may very likely have been originally confined to one of them. It is of the greatest practical

importance to realize these facts, since, as we have recently been shown by Brewer[6] and others, the detection of the renal condition at an early stage, before its fellow organ has been attacked, gives us the best chance of saving the patient's life, as was done by Brewer by nephrectomy in 3 instances and by nephrotomy in 1. McCosh, Cabot, and Farrar Cobb have also saved one patient each by renal incision and drainage (Farrar Cobb[7]).

The difficulty lies, in these cases, in detecting the renal infection at a time when nephrectomy might offer the chance to save life. This is owing to the fact that the renal symptoms are usually masked by those of what appears to be a more or less systemic septicemia. The most reliable sign of the presence of a unilateral renal infection of the sort of which we are speaking is tenderness on pressure over the point of junction of the twelfth rib with the outer border of the quadratus lumborum muscle.

In some instances the symptoms simulate very closely those of acute appendicitis or cholecystitis; such was the case with those reported by Farrar Cobb,[7] McCosh,[8] and Cabot.[9]

In this connection the following summary, which Brewer presents, of some experiments done by him, is of interest:

"A review of these experiments will show that none of the control animals which received a moderate dose of pathogenic bacteria directly into the circulation without other injury, developed a surgical lesion of the kidney.

"Of the 16 which, in addition to the inoculation, received an injury to one kidney, 5 showed no lesion, or only hyperemia and parenchymatous degeneration. Two of these animals died within twenty-four hours, of acute septic intoxication. Of the remaining 11, all developed distinct surgical lesions of the kidney. In 8, the lesions were unilateral and limited to the injured kidney. In 3, the lesions were bilateral. In 1 of the bilateral cases the lesions were practically equal in extent and in severity. In the other 2 the lesions in the uninjured kidney were mild in character, and undoubtedly would have recovered under favorable conditions. The renal lesions produced by these experiments were practically identical with those observed in our clinical cases. . . . They" (the experiments) "demonstrate in a very conclusive manner that injury to a single kidney, whether produced by trauma, by the presence of a foreign body in the pelvis, or by an acute obstruction of the ureter, certainly acts as a strong predisposing factor in the evolution of a surgical lesion of that organ" (the kidney).

Brewer reports 13 cases in the human subject (2 of them were in the care of his colleague, Dr. Blake) of unilateral renal infection of hematogenous origin. Operations were performed in 11 of them by Brewer,

as follows: in 5, nephrotomy and drainage, with 4 deaths; in 1, by incision of a perirenal abscess, with 1 death; in 7, by nephrectomy, with 1 death.

Pathology.—Plate XXXIII, Fig. 1, shows the gross appearances of the early stage of septic infection of the kidney.

Morris[5] states that in the large majority of the cases suppurative pyelonephritis originates in an ascending infection; in some, however, it reaches the kidney through the blood current.

The changes in the kidney which precede actual infection in many instances are such as to render the organ peculiarly liable to receive it. There is a dilatation of the canaliculi and a moderate sclerosis of the renal substance. The pelvis and calices become thickened. More or less congestion of these parts is present. These changes take place in a certain proportion of the cases in which obstruction to the urinary outflow exists in some part of the lower tract—frequently urethral stricture or prostatic enlargement.

The infection of the bladder, which is very likely to occur under these circumstances from the passage of instruments into it, is easily propagated to the renal pelvis and kidney, especially when they are already prepared to receive it.

Morris found 39 cases of pyelonephritis in 2610 postmortem examinations recorded in ten years at the Middlesex Hospital; 26 of them were suppurative. In 12 cases, pyonephrosis was associated with suppuration in the renal substance. In but 1 case was there perinephritic abscess in connection with the renal condition. Nineteen of the cases were, and 7 were not, associated with infections of the lower urinary organs; of the 7, 4 were manifestations of pyemia.

In a further analysis of 75 cases of suppurative nephritis, exclusive of pyonephrosis, made by Morris, it appeared that 51 were secondary infections from the bladder or pelvic organs; 13 were due to renal calculus, and the remainder occurred in the course of general diseases. In a large majority of the ascending infections *both* kidneys were involved in the suppuration.

Microscopic Changes in Suppurative Pyelonephritis.—The microscopic changes seen in suppurative pyelonephritis of ascending infections are: an increase of the connective tissue, sometimes unevenly distributed through the kidney. According to Albarran, the adjacent parts of the renal substance in some instances appear to undergo compensatory hypertrophy. The canaliculi are dilated and contain an exudate of leukocytes, which is also conspicuous about the glomeruli. The interstitial tissue becomes involved in purulent infiltration. The tubules, epithelium, and interstitial structure in the affected areas are destroyed and replaced by purulent foci. Surrounding these are zones of con-

PLATE XXXIII

FIG. 1

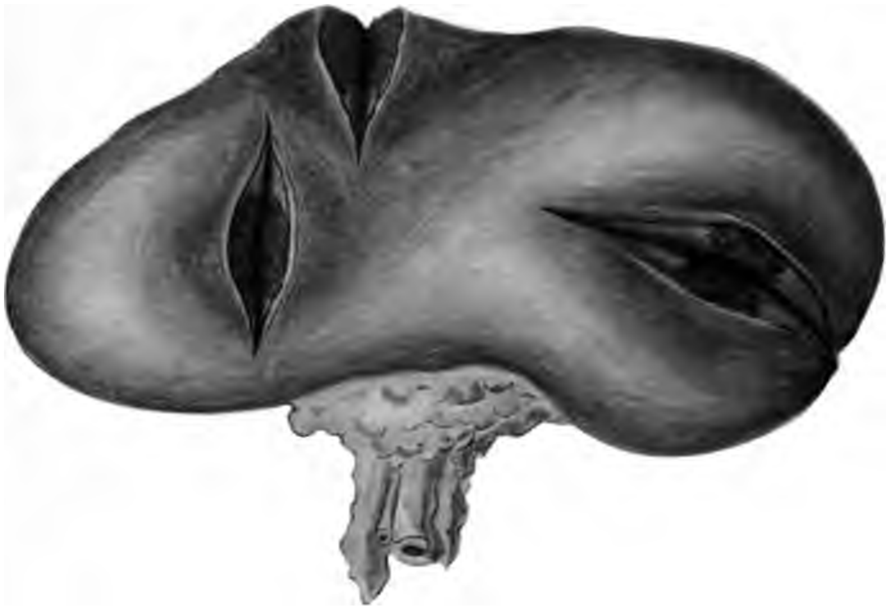

FIG. 2

SEPTIC KIDNEY. (F. Tilden Brown.)

Fig. 1.—Early stage.
" 2.—Late stage.

gestion, and sometimes small areas are occupied by extravasated blood. The centres of the pus collections contain great numbers of bacteria.

Morris[5] refers to the interesting experiments of Albarran, in which he introduced microörganisms into the ureter of one kidney, and noted the effect upon this organ and also upon its fellow of the other side. It appeared that the first evidence of infection of the kidney was congestion, which was attended by subcapsular hemorrhages and marked increase in the size of the organ. Suppuration took place about the third day, and total destruction of the kidney finally resulted in consequence of the pathological changes which took place as the process extended.

There were no changes to be seen for several days in the opposite kidney other than slight congestion and sometimes a few ecchymoses. About the sixth day, however, suppuration occurred in the form of miliary abscesses immediately beneath the capsule. Later the process extended into the renal substance. In but one instance was the renal pelvis involved in the pathological changes.

Morris refers to the fact that if infection of the renal substance takes place through the lymphatics which communicate with those of the ureter, the suppuration will begin in the interstitial tissue; whereas, if it reaches the kidney by the blood current, or by the urinary channels directly, as in an ascending infection, it will be manifest primarily in the terminal capillaries and in the renal tubules, respectively, but, as Morris very properly points out, it is often impossible to determine the avenue of approach in cases of suppurative nephritis and pyelonephritis, since all the distinct parts of the organ are involved in some instances, and the processes are so intermingled as to make the original source of the infection indeterminate. He also states that the small abscesses are more numerous in the cases in which the infection has entered by the lymph channels, and that they are then almost entirely confined to the cortex of the kidney.

The same writer quotes Albarran as having shown that the roads taken by the special kinds of bacteria are distinct from each other. The Bacilli coli communis, for example, "ascend the medullary canals until they reach nearly to the cortical tubules, where they form large masses. They can also be seen traversing the walls of the tubules and passing into the lymphatic spaces. In the cases of streptococcus infection . . . the microbe tends much more to propagate itself by the bloodvessels and the lymphatics."

CIRCUMSCRIBED SUPPURATIVE NEPHRITIS OR ABSCESS OF THE KIDNEY.—Unlike the diffuse form of renal suppuration, with which we have just been dealing, and in which the suppurative processes are disseminated throughout the kidney, or through a great part of it, in the manner

described, the term abscess of the kidney is meant to designate the condition of suppuration which takes the form of one or more abscesses of considerable size. This may be the result of the confluence of several small foci of pus; from the lodgement of embolus in one of the branches of the renal artery; from infection occurring in an area of the kidney which has been injured by the presence of a calculus; or in the parts of the organ which have been bruised or lacerated by other kinds of traumatism.

PYONEPHROSIS.—This term is applied to kidneys in which pouches have been produced which contain pus or urine, or both. The condition may be brought about either as the result of suppurative nephritis or by the infection and suppuration of an already hydronephrotic kidney. The latter is the more frequent of the two. In some cases the pus-containing pockets spontaneously evacuate themselves and then refill; in others, the pouches remain always more or less full. The former condition is termed *intermittent pyonephrosis.*

In pyonephrosis resulting from infection of an already hydronephrotic kidney, the destructive influence of the suppuration produced by the bacterial invasion is superadded to the injury of the renal substance already in progress.

The secondary changes which are due to renal suppuration are: propagation of the process to the perinephritic tissue or to neighboring organs; thickening of the capsula vera; the formation of adhesions between the kidney and adjacent parts.

Symptoms and Diagnosis.—Clinically, it is often impossible to discriminate between suppurative inflammation of the renal pelvis per se and pyelonephritis; furthermore, the symptoms of ascending infections of the renal pelvis and of the kidney, and of the miliary suppurations of hematogenous origin which occur in connection with systemic diseases are often so obscured by those of the primary malady that they are overlooked, and sometimes, especially in the latter class, cannot be detected at all. As Watson[10] points out: "The metastatic miliary suppurations which are, for the most part, limited to the outer cortical portion of the organ, and especially such as are observed in connection with the general septic-pyemic processes, and, in cases of ulcerative endocarditis, as a rule, give rise to no renal symptoms that are recognizable. Usually, the original disease completely masks the local symptoms."

With regard to the suppuration and abscess formation which occur in the train of renal traumatism, or by hematogenous infection from primary foci of disease which are situated on the mucous membrane or on the skin, he says, "The clinical evidences of renal lesions are never lacking." These are: fever, which is oftener intermittent than con-

tinuous, and marked by recurring chills at irregular intervals; rapid pulse; anorexia; prostration; and finally by stupor, delirium, and a typhoidal condition in the severer forms of the disease.

Local evidences of the renal condition in this class of cases are: pain, tenderness on pressure over the kidney or kidneys, and such signs as may be furnished by the urine.

The pain is sometimes localized strictly in the kidney, sometimes it is radiating; in the latter case it shoots downward along the course of the ureter to the scrotum and onto the thigh, resembling the pain of renal colic produced by calculus. It is, however, less severe than that which is caused by stone.

The kidney is not often enlarged sufficiently to be felt unless the pus foci take the form of one or two large abscesses; even then palpable enlargement of the organ may not be present, for the abscess may be located high up toward the diaphragm and beyoud the reach of the fingers.

The Urine.—Pus will be present in the urine except in the cases in which the abscess is situated in the kidney substance and does not communicate with the renal pelvis or calices; when it is so situated, pus may be absent in the early stages, and even throughout the course of the malady. In other instances it suddenly appears some time after the inception of the disease. This is an indication that an abscess of the renal substance has broken into a calyx or into the renal pelvis. Pus may appear intermittently in the urine; this is the sign of the successive discharge of separate pus collections into the renal pelvis or calices.

If the renal pelvis is involved in the suppurative process, pyuria is constant.

Unless in large quantity, the pus from suppurations of the renal pelvis and the kidney settles comparatively slowly into the bottom of the vessel into which it is poured.

Pus may disappear from the urine after having been present, and this is usually due to the temporary obstruction of the ureter by masses of sloughing kidney tissue that are sometimes cast off during the suppurative process.

Finally, pus may break into the perirenal tissue and cause suppuration there. This occurrence is, in some instances, accompanied by a sudden disappearance from the urine of the pus which has formerly been present in it.

Ordinarily the urine is acid. In unilateral infections the quantity of the secretion is usually undiminished unless the other kidney is already functionally defective. In cases of bilateral infections the quantity of urine is decidedly diminished.

Microscopic quantities of blood may or may not be present in the urine. In some cases, hyaline, granular, and pus casts are found, but they may not appear at all.

The amount of albumin corresponds to that of the blood and pus.

In a few cases anuria and fatal uremia occur.

The Chronic Form.—This form of the malady is characterized by milder symptoms of similar character to those just described. Sometimes the course of the disease is intermittent; periods of pain, fever, and irritability of the bladder, together with more or less grave constitutional disturbance, alternate with remissions. In some of these cases there are recurring chills and heavy sweats, following febrile attacks. Dyspeptic symptoms are apt to be conspicuous. The urine may be increased in quantity.

Irritability of the bladder is often a prominent symptom, even when there is no infection of that organ.

Ascending Infection.—In this form of renal infection the kidney symptoms are liable to be overlooked because of the cystitis, which is the usual source of the renal infection.

Whenever, in the course of obstructive and inflammatory or suppurative conditions of the lower genito-urinary tract there occur marked tenderness, pain in the region of the kidneys, an access of fever, and the other constitutional disturbances already described, they indicate the probable propagation of the infection upward to the renal pelvis and the kidney. Its passage to the kidney itself is usually indicated by the graver character of the symptoms than those which occur in most instances of the infection which is limited to the renal pelvis. In the latter condition casts do not appear in the urine, except when the kidney is already diseased.

The urine will probably be alkaline in the cases in which chronic cystitis exists; the pus and sediment of the urine is much larger and settles much quicker to the bottom of a receptacle than in the cases of suppurative nephritis of hematogenous origin.

Bacteria are often present in large numbers in the urine. In the cases in which the infection of the renal pelvis and kidney originate in an acute cystitis, the local vesical symptoms are very likely to entirely mask the renal condition. The same is also true, though in a somewhat less degree, in the chronic forms of pyelonephritis which arise in connection with chronic cystitis.

The general characteristics of *urinary septicemia* of ascending infections do not differ very materially from those which occur in the hematogenous infections. *In the acute cases* the abscess formation is accompanied by a progressively increasing severity of the general symp-

toms and in a considerable proportion of them of those also which are local to the kidney.

The organ is always enlarged, but this fact often escapes detection. It can usually be felt when the abscess has reached a considerable size.

If the abscess has free drainage through the renal pelvis and ureter, marked diminution of the symptoms often takes place.

The disease in the *acute form* is always a very serious one, and death not infrequently ensues, even when the pus makes its escape as just described.

In other instances the abscess breaks into the perirenal tissue and gives rise to perinephritic abscess there.

The chronic form of the ascending infection is of a much milder character, and may pass unnoticed for months or even years. In some of the cases, however, there occurs great and distressing irritability of the bladder. The presence of a moderate amount of pus in an acid urine, especially if associated with a more or less aching or discomfort in the region of one or both of the kidneys, and the presence of casts and epithelial cells from the renal pelvis in the urine from time to time, are very strong evidences of the existence of chronic pyelonephritis.

In the *acute cases*, if associated with acute cystitis, the use of the cystoscope is impracticable; in the chronic form of the malady the instrument may be of much value in clearing up the diagnosis.

Symptoms of Pyonephrosis.—The typical symptoms of pyonephrosis are pyuria and the presence of a tumor in the loin presenting the characteristics which identify it with the kidney.

In the cases in which infection converts an already existing hydronephrosis into a pyonephrosis, it is severe in character and sudden in its onset. Pain and tenderness of the distended kidney are present under these circumstances.

Treatment.—So long as the surgeon is not reasonably assured of the existence of suppuration in the kidney, the treatment should be palliative; when the contrary is true, the treatment should be surgical, and its essential aim should be to free the kidney of its pus as completely and as promptly as this can be done.

Palliative Treatment.—In cases of suspected acute nephritis or pyelonephritis in which the existence of actual suppuration cannot be determined, palliative treatment should be at once applied, and should be directed to the primary source of the infection as well as to the renal condition, whenever the former can be reached, *e. g.*, in cases in which the bladder is the original starting point of the process by which the kidney becomes secondarily involved, the cystitis should receive careful

attention; in those in which a carbuncle gives rise to an hematogenous renal infection, the carbuncle should be promptly dealt with, and so on.

In Cases of Catarrhal Pyelonephritis.—The occurrence of suppuration, which may supervene in this class of cases, can often be averted by the employment of palliative measures. These are: absolute rest in bed, counterirritation over the loins, or depletion by cupping in the same region, free diaphoresis, diuresis, and catharsis, milk diet and the administration of urotropin. Keyes[4] urges the importance of continuing this drug for long periods, beginning it with full doses—3 to 4 grams daily—until bacteriuria has ceased; then going on with doses of 1.5 grams daily until the urinary signs of the disease are no longer present. Under the above measures the majority of patients wholly recover.

Operative Treatment.—(For manner of performing the surgical operations see chapter on Technique of Operations on the Kidney.) In considering the operative treatment the following points should be remembered: the frequent occurrence of bilateral infection; the difference in the character of the suppuration in the ascending and the hematogenous infections; the special form of it in cases of pyonephrosis; the importance of including the primary source of the infection—when possible—in the surgical treatment; the futility of directing surgical treatment to the kidney alone in cases in which the renal suppuration is but one of a number of manifestations of general pyemia; the very serious character of the disease, and the failure of palliative treatment to influence its outcome; finally, the condition of the patient in individual cases.

The surgical measures are *nephrectomy* and *nephrotomy and drainage.* (The surgical treatment of calculous nephritis is discussed in the chapter on Renal Calculus.)

Following the indications just mentioned, we shall apply one or the other of these two operations in all instances in which palliative treatment is clearly unavailing or inappropriate.

In Cases of Diffuse Hematogenous Acute Infection.—The most interesting and the most critical cases are those of the diffuse hematogenous acute infections which are manifested in the kidney by numerous scattered foci of pus, and by a few larger pus collections, when the small abscesses become confluent.

We have already referred (see page 147 of this chapter) to the results which have been obtained by the performance of nephrotomy and nephrectomy, respectively, in cases of unilateral renal infections of this character. That the patient's life may sometimes be saved by nephrotomy, even in this particular form of suppuration of the organ, has been shown by the few cases in which it has been successful, and which we

have previously quoted (see page 147). The other side of the picture is shown in the 5 cases in which Brewer did the operation, and in which but 1 of the patients lived, and to these we are obliged to add 3 from the writer's own experience, in which death followed splitting of the kidney through its whole convex border, cleansing all areas of suppuration, and evacuating all pus foci that could be detected on the surface or within the organ, and draining the kidney. Over against these results we may place the brilliant series of successful nephrectomies done by Brewer, to which we have already referred, in which he lost but 1 out of the 7 of the patients thus treated.

The writer is of the belief that Brewer's idea of applying nephrectomy to these cases is the right one, provided it can be established with reasonable certainty that the infection is still confined to one of the two kidneys and if there does not exist elsewhere in the body a lesion of such gravity that it is likely to prove fatal.

It is usually impossible in the typical examples of this particular variety of renal suppuration to reach and evacuate all the pus foci that are scattered throughout a wide area, if not the whole, of the organ, and to empty and cleanse a part of them only would seem to be a futile procedure in the great majority of cases. When, therefore, we can arrive at the conclusion by means of the diagnostic measures already detailed under the heading of Symptoms and Diagnosis, that there is good reason to believe that there exists a unilateral renal suppuration of the character which we are at the moment discussing, we are in favor of following Brewer's example and of removing the kidney.

Nephrotomy and drainage are the obvious methods of treatment to employ whenever there are large collections of pus in the kidney, such as have been described earlier in the chapter, provided the suppurative process has not destroyed so much of the organ as to make it obvious that it can no longer exercise any important functional activity. When the latter condition exists, nephrectomy, either as a primary or secondary operation, should be performed.

Special Considerations Connected with the Performance of Nephrotomy in Cases of Renal Abscess from Ascending Infections.—When the operation is called for in this condition the kidney will always be congested and will bleed freely when incised. In some cases the organ will be much increased in size and will be difficult to explore thoroughly through the ordinary lumbar incision, which is that which should be employed at the outset.

When the abscess is near the surface of the kidney, it can be easily detected by palpation with the finger tip, its presence being revealed by an area of fluctuation; when, on the contrary, it is deeply situated in the renal substance, or is small, it may not be palpable. Under these

circumstances, the kidney should be explored with a fine aspirating needle, and pus should be evacuated by incision wherever it is found. It is of the utmost importance that *all* collections of matter be evacuated, else the patient will not have been benefited by the operation, but, on the contrary, may have been made worse.

Bilateral infection is still more difficult a problem to solve with respect to treatment. To operate and to evacuate the pus from one kidney, leaving untouched a similar process in the opposite one, is worse than useless. From the writer's personal experience with the small number of patients upon whom he has performed *bilateral nephrotomy at one sitting*, he is of the opinion that the risk encountered by the *simultaneous* performance of the operation on both kidneys is much less than that involved in leaving untouched a suppurative process in the second kidney when doing nephrotomy upon its fellow.

The indication in cases of acute abscess formation of the kind under consideration is to give free exit to the retained pus, and *to all of it.* If this is not accomplished by the operation, we fail to fulfil that indication, and, correspondingly, will fail in most instances to save the patient, or shall not give him a better chance, if so good a one, than he would have had if treated expectantly.

Statistics of Operations in Cases of Renal Suppuration.

	Cases.	Deaths.	Operative mortality. Per cent.
Nephrectomies—Pyonephrosis.			
Morris	29	5	17.2
Primary Nephrectomy.			
Schmieden	87	24	27.6
Kümmell	37	5	
Israel	18	3	
	171	37	21.6
Secondary Nephrectomy.			
Israel	6	2	
Kümmell	6	1	
Schmieden	51	8	
	63	11	17.4
Nephrotomies.			
Israel	17	3	
Kümmell	34	4	
	51	7	13.7

RESULTS OF OPERATIONS IN CASES OF SUPPURATIVE PYELONEPHRITIS.

LUMBAR NEPHRECTOMY.

	Cases.	Deaths.	Operative mortality. Per cent.
Küster	143	24	16.7

NEPHROTOMY.

	Cases.	Deaths.	Operative mortality. Per cent.
Küster	100	17	17.0

(23 of these later had secondary nephrectomy.)

TREATMENT OF PYONEPHROSIS.—The surgical treatment of pyonephrosis is the only one which can be effective. The character of the operation that is to be performed will be determined by the special conditions presented in the individual cases. The surgical methods are as follows: (1) Lavage and drainage through ureteral catheter. (2) Nephrotomy. (3) Nephrectomy. (4) Removal of obstruction to the free escape of the urine and pus, (*a*) by removal of obstructions or bends and twists in the ureter, and (*b*) by correcting malposition of the kidney.

Lavage and Drainage by Ureteral Catheter.—Some surgeons have extended this practice from its more useful field, viz., cases of pyelitis, to those of pyonephrosis. Our personal experience of this method of treatment is nil. The good results claimed have been so few and it appeals to us so little that we feel disinclined to adopt it.

Nephrotomy.—Nephrotomy, if properly done, by which we mean that all pus sacs shall be thrown into one by breaking through the walls which intervene between them and that free drainage be afforded to all of them, fulfils the immediate indications for treatment in all cases in which there are urgent symptoms; that is to say, it gives the kidney the chance of reëstablishing its function when there is enough uninjured secreting substance left to resume it and to free itself of the dangerous presence of the infection and its consequences. It is the operation of choice, and the only justifiable operation when we are ignorant, as must often be the case, of the capability of the other kidney and whether or not it is infected; and also in cases in which there is a focus of infection in the lower parts of the tract from which the other kidney may become infected subsequently, which condition would make the performance of primary nephrectomy upon the pyonephrotic kidney of questionable propriety.

The dread of renal fistula has led surgeons to avoid nephrotomy, and, as we believe, to substitute nephrectomy for it in *too many* cases of this kind, since nephrotomy will certainly result in urinary fistula whenever, as is often the case, an obstruction to the free escape of urine from the kidney remains in the lower part of the tract, after its performance.

Urinary fistula in the loin, it is true, is a trying condition for the patient, but it is by no means an intolerable one, provided the drainage apparatus is so arranged as to cause the patient no discomfort and to insure his being kept dry, and this can be done. (See chapter on the Technique of Operations on the Kidney.)

Of the two evils, namely, the danger arising from the performance of a primary nephrectomy upon the pyonephrotic kidney and the discomfort attending a urinary fistula, the latter should be unhesitatingly chosen under the circumstances named above, rather than to sacrifice a kidney —the contribution of which to the urinary function as a whole may still be an important one—and endangering the patient's life by performing a primary nephrectomy.

In these cases the initial operative step will frequently be nephrotomy, even if it is thought probable that the kidney will be removed later, and we shall thus have an opportunity to inspect the organ after incising it and to determine the amount and, in a general way, the condition of the renal parenchyma which still remains. It is, however, well known that the functional capability of such a kidney cannot be accurately determined by the amount of the parenchyma which it still possesses, for there are numerous examples of such kidneys which have a layer of parenchyma so thin as to appear to be entirely inadequate for carrying on a sufficient degree of functional work to make it worth while to preserve them, and yet they perform a sufficient and sufficiently good secretory work to keep the patient alive for many years. On the other hand, there may be a thick layer of parenchyma, and yet the amount of work that it is capable of doing will be wholly inadequate, because of the presence in it of pathological processes.

There is but one way by which the functional capability of such kidneys can be estimated (this applies to the cases in which an obstruction exists in the course of the ureter which has prevented the urine being drawn by ureteral catheter), viz., by examination of the urine which is secreted several days after a free escape of it from the kidney has been provided by nephrotomy. The estimation cannot be made *immediately* after the operation, because the functional capability of such kidneys continues to improve for a good while afterward.

In cases of acute, complete renal retention, due to obstruction of the ureter or renal pelvis, occurring in infected kidneys, which are found upon being incised to have a fair amount of secreting substance left in them, and when doubt exists as to the functional capability of the other kidney, nephrotomy and drainage is the only procedure that is justifiable, until the subsequent urinary examinations of the urine drained through the loin have shown what amount of work the organ is capable of doing.

Later, the question of doing a secondary nephrectomy will be determined by the nature of the conditions presented.

Nephrectomy.—The *contra-indications to primary nephrectomy* have just been stated, and the conditions which constitute the *indications* for its performance are as follows: the knowledge that the other kidney is not infected, and that it is functionally capable, together with the discovery, upon inspecting the pyonephrotic organ, when it is incised by a nephrotomy, that its secreting substance is *unquestionably* so far destroyed as to make it incapable of rendering a useful degree of functional service thereafter; also, if the condition of the kidney is such as to make free and complete drainage of it impossible.

Illustrative Cases.

Case I.—*Bilateral Renal Infection and Suppuration; Rupture of Renal Abscess into the Descending Colon.*—A woman, aged thirty-five years, in good health until one year ago; since then has had more or less discomfort in the left renal region.

Pain and tenderness of the left kidney became very marked two weeks ago.

Rapid loss of weight, strength, and appetite have taken place in the same time. No urinary symptoms have been noticed by the patient.

On entering hospital her condition was as follows: Dull and apathetic; tongue coated; moderate constipation; urine somewhat diminished in amount; specific gravity, 1015; color rather high; sediment large in amount, consisting chiefly of pus and microscopic blood in considerable amount; albumin, a large trace; urea slightly diminished.

Temperature, 99.5° F. Pulse 85, weak and regular.

Marked rigidity of the muscles of the left side of the abdomen.

Tenderness on pressure over the left kidney; none over right side.

Operation, January 3, 1907.—Under ether a well-marked tumor could be felt in the region of the left kidney.

The patient was placed on the Cunningham table, resting on her right side, and the left kidney was exposed by the usual lumbar incision, parallel with the outer border of the quadratus lumborum muscle.

The kidney extended from the diaphragm to the level of the anterior superior spine of the ilium. It was bound to the adjacent structures by extensive adhesions. The adhesions which held it thus fixed were dense and very firm.

The perinephritic fat envelope was universally and very closely adherent to the capsula vera over its entire extent; the latter was but moderately thickened. The perirenal fat was much atrophied.

The surface of the kidney was exposed with much difficulty, owing to the presence of the adhesions.

At the upper end of the organ there was an area of fluctuation. An incision at this point opened an abscess and gave exit to about two ounces of pus. The interior of the renal pelvis was explored through this opening. The abscess cavity communicated with a dilated calyx and the renal pelvis. No other collection of pus could be found. It was noted at the time of making this exploration that there was a mass, composed of dense adhesions, which covered the pedicle of the kidney anteriorly and prevented its being mobilized without incurring grave danger of tearing the renal vein. No calculus was found in the kidney.

The patient did well for the first two days following the operation, then failed, and died on the fifth day after its performance.

Autopsy.—A partial autopsy only was permitted.

The autopsy showed the pedicle of the left kidney, especially in front, to be covered over with a mass of dense adhesions, which completely concealed the bloodvessels, and which closely united the anterior surface of the kidney with the overlying peritoneum and the descending colon. Within this mass was a second abscess, which had ruptured into the colon shortly before death, and which placed the renal pelvis and the bowel in communication.

In the right kidney there was also an abscess of moderate extent and pyelonephritis. The bladder was not infected. The origin of the suppuration was left in doubt.

Case II (Fig. 361).—A man, aged forty-three years, who had been the subject of urethral stricture for a long time, and who presented evidence of infection of the left kidney when he first came under the care of the writer.

The stricture was treated by a combined operation of internal and external urethrotomy. The operation was followed by marked constitutional disturbance and high fever. At the end of the fourth day an easily palpable tumor was felt in the left loin.

Four days later the left kidney was exposed by the usual lumbar incision, and was freely incised through its convex border. The kidney was enormously distended and filled with pus. No communication could be established between it and the bladder through the ureter, the latter being entirely obstructed a short distance above the bladder. All partitions between the separate pockets of pus in the kidney were broken down by the finger, so that its interior was converted into one chamber.

The renal parenchyma was much atrophied, and the temptation to remove the organ was great, but the patient's condition was too critical to permit its being done.

The kidney was drained. The patient made an excellent recovery; the ureter continuing to be impervious, permanent drainage was arranged through the loin by a tube passing from the renal pelvis through the kidney and tract of the operative wound, and conveying the urine to a can suspended upon the buttock of the patient.

He remained in excellent health and was in active business during the next nine years.

In this interval the wound in the perineum resulting from the external urethrotomy was kept open by the passage of bougies, and the bladder was irrigated for the purpose of lessening the chance of an ascending infection of the opposite kidney. At the end of that time the right kidney suddenly became infected, and the writer's colleague, Dr. Thorndike, opened and drained this kidney.

FIG. 361

Photograph of patient with renal fistula.

The patient again made rapid recovery, and wore a receptacle and similar contrivance for draining the urine from the kidney on the right side to that which was in operation upon the left side.

The patient's condition continued to be excellent until the end of the third year following the second operation, at which time a considerable quantity of blood appeared in the urine from the kidney last operated upon, and bits of phosphatic concretions began to be passed through the fistula. At the end of two months the writer cut down upon the right kidney and removed a considerable quantity of phosphatic concretions and phosphatic crystals which had become united into soft masses.

Shortly after recovering from this operation, the time being twelve years after the first operation was done upon the left kidney, blood appeared in the urine coming from that organ, and a radiograph revealed the presence of a stone about the size of the last phalanx of the thumb, situated near the outlet of the renal pelvis.

A fortnight later, during a visit of the patient to the office of the writer, a profuse hemorrhage took place from this, the left, kidney on removing the drainage tube, and apparently without any exciting cause.

The patient was removed to a private hospital near by, the hemorrhage having been arrested by packing the fistulous tract from the inner edge of which it appeared to be coming.

On removing the packing on the next day, the bleeding again started, and it became necessary to lay open the fistula in order to find the point from which the hemorrhage was proceeding, and to stop the bleeding. This was done, and at the same time the stone mentioned above was extracted without difficulty. It was a pure phosphatic calculus, weighing a little less than one ounce.

This operation was done eight months prior to the present time. There has been no bleeding from either kidney since then, and only an occasional small mass of phosphatic sand has appeared.

The patient has resumed his occupation, and continues to be in good health up to the present time, thirteen years after the first operation was performed.

This case illustrates a number of interesting points, among which the following may be mentioned: The amount of renal substance which remained in the kidney first operated upon, at the time that the nephrotomy was performed upon it, was so small as to appear to be entirely inadequate to carry on a useful degree of functional activity; nevertheless, it continued to secrete a urine which contained but little less than the normal amount of urea and other solids, and, with the exception of more or less pus and the formation of the calculus many years after the operation, this organ has constantly contributed a large share of useful functional work. Had the kidney been sacrificed by nephrectomy, the patient in all probability would have succumbed to the infection of the fellow organ when it took place later.

PERINEPHRITIS. PERINEPHRITIC ABSCESS.

Definition.—Inflammation and suppuration of the perirenal fat and connective tissue.

Etiology.—All acute inflammatory and suppurative perirenal processes represent bacterial infection of one kind or another. The more frequently encountered varieties of the infections are those of the Bacillus coli communis, Staphylococcus pyogenes aureus, more rarely streptococcus, typhoid bacillus, and pneumococcus infections are seen.

Infection reaches the perirenal tissues by the blood current—probably in the form of minute emboli—by the lymph channels, and by direct

extension from an already present infection in the kidney, renal pelvis, ureter, or some other of the immediately adjacent structures; also, from the breaking into the perirenal tissue of an abscess of some contiguous part—gall-bladder or appendix. Perirenal infection is common in connection with traumatic lesions of the kidney.

Pathology.—In the milder forms of perirenal inflammation the structural changes are limited to a moderate thickening of the capsula vera and to the formation of but a small amount of connective tissue in the perirenal fat envelope which creates adhesions between it and the kidney capsule, on the one hand, and the lumbar fascia on the other.

In the severer grades the perirenal fat is converted into a dense sclerotic mass, closely surrounding the kidney and at times intimately adherent to it; at others, so slightly that the organ can be readily shelled out of this envelope. The transformed perirenal tissue in the more serious form of the condition may be two or more inches in thickness.

Morris[5] describes a lipomatous form of perinephritis in which there is a large increase of the perirenal fat, which penetrates the kidney in the course of the bloodvessels and finally converts it into a fatty mass.

Perinephritic Abscess.—Perinephritic *suppuration* appears in two forms: (1) diffuse, and (2) as separate small foci of pus more or less widely disseminated through the perirenal fat tissue. In still another class of cases the further extension of suppuration is limited by the formation of connective tissue.

Rupture of the Abscess into Neighboring Organs or Structures.—The relative proportion in which the different organs are secondarily involved by rupture of perinephritic abscess is indicated by Küster in a series of 34 cases, as follows:

Pleura and bronchi	18
Colon	11
Peritoneal cavity	2
Bladder	3
	34

Morris[5] estimates that the abscess ruptures into the pleural cavity or lung in about four out of every twelve cases treated expectantly.

Symptoms and Diagnosis.—PERINEPHRITIS WITHOUT SUPPURATION.—*Pain.*—The degree of pain depends much upon the acuteness or the reverse of the inflammation. In the more acute cases, pain may be very severe, though it rarely attains the intensity seen in connection with actual suppuration. It is usually located in the loin of the affected side; sometimes it extends to the front of the abdomen, down the thigh, or into the groin.

The condition with which it is most likely to be confused is hip disease. Extension of the thigh is resisted and pain is increased by attempts to extend it in both maladies.

The distinctive features of the two conditions are, respectively, the tenderness on pressure on the loin in the perirenal inflammation, and its absence in cases of hip disease, while the pain of the latter is chiefly located about the hip-joint and is increased by rotation of the head of the femur and by striking upon the trochanter. These signs are not present in perinephritis.

The Position of the Patient.—The position of the patient when standing is sometimes significant of perinephritis. The weight of the body is thrown upon the leg of the other side, the thigh of the affected side is flexed, the patient being apt to lean toward that side and to rest the hand upon the buttock. In walking, the patient seeks to lessen the tension and pressure of the surrounding parts upon the inflamed area by involuntarily immobilizing the psoas and iliacus muscles, in order to avoid all movement of the region implicated. He is unwilling to stoop forward. In some instances the spine is held more or less rigid. There is no swelling in the loin.

Systemic Symptoms.—The temperature is usually not very high. Chills, although occasionally occurring when pus has not formed, are ordinarily indicative of suppuration. The tongue is coated, anorexia and sometimes vomiting occur. The latter is not a distinctive symptom.

SYMPTOMS OF PERINEPHRITIC ABSCESS.—*When suppuration does take place*, and especially if it occurs rapidly, the symptoms just described in connection with perinephritis are intensified. Pain and tenderness are more marked; the patient is unwilling to make any movement that can be avoided; a constitutional disturbance is more serious; chills and high fever are apt to announce the formation of pus; leukocytosis is usually well-marked. Later, the essential characteristic is the presence of a swelling in the loin, which is accompanied by more or less redness and tumefaction of the integument.

When the abscess is of more gradual formation, as it is in some of the cases in which it is secondary to calculus or other intrarenal condition, and the pus is well walled off by the formation of connective tissue, the symptoms are milder and the progress of the malady slower and more insidious. The pain may then take the form of a dull ache only. It is usually in the loin, sometimes at a more distant point, *e. g.*, the knee-joint or thigh. The temperature may be but little elevated.

If the perirenal suppuration is secondary to the same process in some adjacent part, such as the gall-bladder or appendix, it may be masked by the symptoms to which the original condition gives rise.

In the cases in which the abscess forms in the perirenal tissue primarily, or in which it represents an extension of the infection from the kidney, the local symptoms will be determined largely by the direction taken by the pus and the rapidity with which it extends. If it be toward the diaphragm, it may give rise to symptoms closely simulating those of pleurisy or pneumonia of the lower part of the lung. In other cases the pain and tenderness may be difficult to distinguish from those that occur in connection with an inflamed gall-bladder; and, again, there are cases in which the symptoms closely resemble those of appendicitis.

Tenderness on pressure in the loin, and in the later stage of the suppuration, the surface evidences of perirenal suppuration, which have already been mentioned, will aid in discriminating the one from the other of these conditions.

Symptoms Present when the Abscess Breaks into Adjacent Parts.—In the more fortunate cases pus makes its way to the exterior of the loin, and after being preceded by the usual superficial signs of the approach of an abscess to the surface—redness, œdema of the skin, and fluctuation—at length breaks through the integument and is discharged externally. Healing and complete recovery may follow this; or, on the contrary, fistula may form. This is especially liable to happen if the abscess stands in communication with the interior of the kidney, its pelvis, or the ureter. Such fistulæ may continue to discharge for an indefinite time, but in a certain proportion of the cases spontaneous healing takes place.

Instead of taking this favorable course, the abscess may break into one or another of the parts already noted. In this case the symptoms will become atypical, or the picture, which may have been characteristic of the perirenal suppuration, may suddenly change and take on the appearance of peritonitis in case of the invasion of the abdominal cavity by the pus, or of empyema or pyopneumothorax if the pleura and lung are involved.

As in the cases of non-suppurative perinephritis, so, too, with some of those in which abscess formation does occur, there may be but comparatively slight disturbance of the general condition and but little local evidence of the existence of the malady. The patient may be going about, and even attending to his ordinary occupations, if they are not of a strenuous character. *There is never an actual absence of local or general disturbance;* either there will be more or less malaise, loss of strength and appetite, a persistently furred tongue, etc., or the patient will show some one or another characteristic evidence of the local condition, *e. g.*, a change of gait in walking, or in the attitude of standing; by bending to one side, or else by tenderness in the loin, etc., even though these signs be but slightly marked.

In the acute cases the general condition is usually seriously affected, and if the pus is not evacuated soon enough, septicemia results, and is often fatal.

Treatment.—The treatment of *perinephritic inflammation without suppuration* consists in absolute rest, the application of leeches over the affected loin, hot applications and hot hip baths, morphine to combat the pain, and at the outset a brisk purge. The action of the bowels should be free throughout the attack, and the kidneys should be kept active by means of diluents.

The *treatment of suppurative perinephritis* may be summed up in the one phrase: *early incision and evacuation of the pus.*

Furthermore, it may be said that the surgeon need not, and should not, hesitate to operate in the cases in which he feels some doubt whether the pus has already formed, for it has been amply demonstrated that *even when no pus has been found* upon making a lumbar incision, yet the patient will obtain complete relief from pain and constitutional symptoms soon after the incision has been made. In some instances in which no pus is found, it has appeared on the following day.

In some of the cases in which this happens, the pus is found to be still confined within the capsula vera, or walled off high up near the diaphragm, and has been overlooked by the operator.

When we counsel *early* incision, we do not mean *immediate* incision. We should, of course, be reasonably assured that suppuration has already occurred before operating. It is better, however, to err on the side of operating too soon rather than too late, for even when pus is not found, improvement will follow the incision, and there is danger in too long delaying surgical intervention.

The incision in these cases should be an exploratory lumbar one—the usual oblique cut parallel with the outer border of the quadratus lumborum—which insures thorough evacuation of the matter. The wound should be allowed to heal from the bottom, otherwise fistula is likely to result.

Fistula following Spontaneous Opening or Incision of the Abscess.—Fistula is most likely to occur in the cases in which the abscess has ruptured spontaneously. In these, especially if the opening is not enlarged by incision, the mouth of the cavity is very liable to close; there will then be a re-accumulation of the pus, and with it a return of the original symptoms.

The liability to fistula is very small in the cases of *primary perirenal suppuration* treated by free incision in the loin. When it is *secondary to suppuration* in the kidney or produced by the perforation of the kidney by a calculus, there is greater probability that fistula will follow. In

these cases it is, of course, the primary condition to the treatment of which surgery should be directed, and not to the secondary perinephritic suppuration alone, which is then only an incident in the case.

The same is true when the perirenal suppuration results from the rupture into the perirenal tissue of an abscess of the gall-bladder or other neighboring focus of pus.

When operating for perinephritic abscess, especial care should be taken to explore the area immediately below the diaphragm, and to pass the finger over the whole surface of the kidney and down the pelvis and upper end of the ureter, for when pus is not found immediately upon reaching the perirenal tissue through the incision, it may be walled off at one of these points and be overlooked if the exploration is not thoroughly made.

In some instances it will be the complication rather than the original perirenal lesion to which surgical treatment should be primarily directed, as, for instance, in the cases in which the peritoneal cavity has been invaded by the breaking into it of the perinephritic abscess, and peritonitis has resulted.

The occurrence of almost any of the serious complications of the perirenal suppuration creates a more urgent demand for surgical intervention and rarely constitutes an indication for abstaining from its employment.

A striking illustration of the value of operative measures in perirenal suppuration is furnished by two series of cases in which perinephritic abscess followed traumatic lacerations of the kidney,[10] which were published in the *Boston Medical and Surgical Journal*, July 9 and 16, 1903. In these series the comparison is made between 21 and 28 cases of perirenal suppuration which were treated expectantly and by operation, respectively. Of the 21 patients treated expectantly, but 4 survived—a mortality of 80 per cent.; of the 28 treated surgically, but 2 died—a mortality of but 7.1 per cent.

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CHAPTER XXV.

RENAL CALCULUS.

Number.—If large, a renal calculus is generally single; if small, it may be single or multiple. As many as 1000 stones or concretions have been found in one kidney. Fig. 362 illustrates a specimen containing the large number of concretions.

FIG. 362

Specimen containing a large number of concretions.

Size.—Calculi vary in size from the minute concretions shown in Fig. 362 to that seen in Fig. 363 and Fig. 370, which is taken from the report of a case by Mr. Shield.[1] (See Illustrative Cases, No. 5, at the end of this chapter.)

Shape.—The shapes of calculi vary according to their position in the kidney, to their being subjected to pressure of other stones or not, and to the presence or absence of certain pathological conditions in the

organ. If calculus lies in the renal pelvis and sends branches into the calices, it will generally assume forms corresponding to them. If it lies loose in the pelvis and is not of great size, it is usually of an oval form. Varied and peculiar forms are often given to calculi, some of which appear in the illustrations of the chapter.

Frequency.—Keyes[2] quotes the statistics of Kraft, which give 40 cases of renal calculi in 2953 postmortem examinations. The relative frequency of renal calculus varies so much in different races and countries that statistical estimates based on examinations made of persons in any special locality are not very reliable or important.

FIG. 363

Large renal calculus. (Warren Museum.)

Bilateral Calculus.—Of 54 of the writer's own cases, 5 were bilateral. Kümmel reports 16 in a total number of 57 cases in which he operated. Kraft says that there were 15 bilateral cases in the total number of 40 which were referred to above. Albarran and Legueu affirm that about one-half of the patients with renal calculi have them on both sides.

Sex.—Men are usually believed to have renal calculi more often than women.

Age.—Morris[3] gives the ages of 188 patients with renal calculus, as follows:

Under 10 years	1
Between 10 and 15 years	10
" 15 " 20 "	20
" 20 " 30 "	54
" 30 " 40 "	50
" 40 " 50 "	34
" 50 " 60 "	17
" 60 " 65 "	2

In the series of 54 of the writer's own cases already referred to the youngest patient was a girl of twelve, the oldest a man of fifty-eight. The average age of the whole number was thirty-eight years.

Chemical Composition.—Uric acid calculi are variously estimated as constituting anywhere from one-half to three-quarters of all the varieties found in the kidney. The estimates, which are based upon operative data, indicate a somewhat smaller percentage.

In 32 of the writer's 54 cases the character of the calculi was as follows:

Uric acid	9
Urates	4
Oxalate of lime	7
Phosphatic masses	4
Mixed calculi	4
Cystine	1
Phosphates	3
	32

Morris[3] gives the chemical composition of 77 calculi as follows:

Uric acid	17
Oxalate of lime	34
Mixed calculi	10
Carbonate of lime	1
Cystine	2
Phosphatic	13
	77

Sir Henry Thompson's table is as follows:

	Cases.	Per Cent.
Uric acid	26	23.7
Oxalates	41	37.6
Mixed calculi	24	22.0
Cystine	3	2.7
Phosphatic	20	18.3
	114	

Total, 223 cases; uric acid, 52.

Physical Character of Calculi.—URIC ACID.—*Color:* Red or reddish yellow; occasionally dark red or brown. *Consistence:* Hard, but less so than oxalate calculus. *Surface:* Smooth, as a rule. *Contour:* Round or oval, when not influenced by pressure, etc.

URATES.—*Color:* Yellowish. *Consistence:* Soft. *Surface:* Smooth. *Contour:* Round or oval.

OXALATES.—*Color:* Usually dark brown, sometimes black. *Consistence:* Hardest of all calculi. *Surface:* Irregular; in some specimens

covered with little nodules, which give it the appearance of a mulberry. *Contour:* Irregular.

PHOSPHATES.—*Color:* White or grayish. *Consistence:* The masses of amorphous phosphates are often pultaceous; triple phosphates are usually brittle, occasionally hard. *Surface:* Sometimes smooth, more often irregular. *Contour:* Irregular, roughly speaking, more or less round or oval.

CYSTINE.—*Color:* Pale yellow; have rather a waxy look. *Consistence:* Smooth and friable. *Surface:* Smooth. *Contour:* Generally round.

Primary and Secondary Calculus.—The term primary is applied to calculi that are formed in kidneys which are not already the seat of pathological processes, while those of which the contrary is true are called secondary.

The conditions in the kidney favoring the formation of secondary calculi are renal retention, infection, and the alkaline decomposition of the urine which occurs as the result of them, under the influence of which there is a precipitation of alkaline salts of the urine.

Etiology.—The etiological factors of renal calculus are twofold: (1) Systemic or general. (2) Local conditions in the kidney. The co-existence of the two is believed to be necessary to the formation of renal calculus.

1. SYSTEMIC OR GENERAL FACTORS OF RENAL CALCULUS.—The systemic or general factors, roughly speaking, may be included under the heading of defective metabolism. This, in turn, results from a great variety of conditions, many of which are but imperfectly understood and most of which are of a complex nature. The following are the most important of them:

(*a*) Derangement of the function of the digestive organs—stomach, intestines, liver, and pancreas.

(*b*) Derangement of the function of the organs or structures charged with the elimination of the waste products of the organism—the skin, the lungs, the lower intestine, and the kidneys.

(*c*) Derangement of the function of the organs or media by which oxygen is taken into the body and distributed through it—the lungs and the blood.

(*d*) Defective supply of oxygen in the air inhaled.

(*e*) Insufficient muscular activity.

Derangement of the Digestive Functions.—Of these different factors, the most important is, perhaps, that which concerns the digestive functions.

The chiefly important factors, with respect to their influence in producing disturbances of the processes of metabolism, which arise from faulty performance of the digestion, are: (1) An excessive fermentation

of the contents of the stomach and intestine (upper part of the intestinal tract more especially); and (2) putrefactive processes in the latter.

The role of bacteria, which are constantly associated with these processes, is probably an important one, but it is but little understood at the present time.

More or less gastritis and enteritis are frequently present under these conditions, and add to the faulty performance of the digestive function. Dilatation of the stomach and intestine which favor stasis of their contents also augment the trouble.

In consequence of the excessive fermentation and of the putrefactive processes, there are formed in the stomach and intestine certain fluid and gaseous products of a poisonous nature, which, being absorbed and distributed to the tissues of the body, work greater or less injury to them, according to the degree of virulence of the poisons on the one hand, and the power of resistance of the cellular elements which are attacked on the other.

The retrograde part of metabolism, when normally performed, produces as its end-results certain waste products, the most important of which is urea. When this phase of metabolism is not normally executed, there appear with, or in place of, a part of the urea which should be produced certain other substances, or an excess of them, which were formerly believed to represent steps on the way to the normal waste products, which failed of being reached because of the influences of one or another of the abnormally performed steps of body metabolism. The correctness of this view is now doubted. Whatever may be the truth, this we do know: that there appear in the urine under the conditions named above, crystals of some of the urinary salts in excess, and that to this fact we may ascribe the formation of renal calculus in many instances.

To these urinary conditions the name of the "urinary crystalline diatheses" has been given.

The most frequent of the crystalline diatheses are the uric acid, oxalates, urates, and amorphous phosphates. Occasionally a patient is seen with a marked disposition to deposit cystine in the urine.

There is, at this time, so rapid an advance being made in the chemical pathology of the human body, and so many conflicting views are being brought forward with regard to such questions as this which we are now considering, that we frankly confess to being quite ignorant with regard to many of the causal factors of these so-called "urinary crystalline diatheses." We shall, therefore, merely state that the former view, that the uric acid excess in these cases was due to defective functional action of the liver, is not so strongly held today as it was, and that it is claimed

by some observers that the source of uric acid is in the breaking down of the nuclei of cellular elements of the bodily tissues, and probably in large measure to that of the leukocytes.

With regard to diet, it appears that, experimentally, the results point to an increase of uric acid being very decidedly brought about by a diet rich in nuclein.

Herter[4] says: "Substances rich in nuclein are a source of the production of large amounts of uric acid. This circumstance is of considerable significance in the treatment of disease. When we wish to avoid the formation of uric acid in excessive amounts, we must be particular not to allow our patients to eat foods rich in nucleins. All tissues in which the nuclei are large in proportion to the cell bodies are rich in nuclein. The thymus gland is an example of this. Young meats have the same peculiarities." Veal is cited as an example.

Herter points out that there is a striking contrast with respect to their influence upon the production of uric acid in the body between the nucleo-proteids and the nucleo-albumins, the former leading to an abundant formation of it, while the latter, as represented by casein, cause a marked reduction in its amount. He suggests that it is on this account that milk diet is beneficial in the treatment of conditions characterized by the excessive formation of uric acid.

Oxaluria.—The causal factors of oxaluria are involved in still greater obscurity than are those of uric acid. Herter refers to the processes of excessive fermentation and putrefaction in the alimentary canal as largely influential in the production of an excess of oxalic acid and the oxalates in the urine. Beyond this it is to be noted, of course, that the condition may arise from the ingestion of oxalic acid in the food.

Phosphaturia.—In this condition there is a more or less frequent precipitation of phosphates in the form of an amorphous powder.

This should not be confused with the deposit of the triple phosphates from alkaline fermentation of the urine. In true phosphaturia the precipitation of the salts is not necessarily due to an excess of them, but to the fact that the urine is neutral or alkaline at the moment of its being secreted.

The more or less frequent deposit of the amorphous phosphates in the urine is in some instances associated with functional nervous disorders, and again it is observed in persons who are apparently in perfectly good health. The writer recalls the case of a gentleman who invariably had a large deposit of amorphous phosphates in the urine preceding and during the times at which he passed his examinations while he was a student in the university, and later in one of the professional schools.

Influence of Diet.—Whatever articles of diet or of drink produce gastritis or introduce into the stomach or intestines substances which are especially prone to undergo or favor the occurrence of fermentation and putrefactive processes, are likely sooner or later to bring about the defects of metabolism and the various factors which are included in it that favor the occurrence of crystalline products from which renal calculus may result.

When we come to name the *special articles* of food and drink which are likely to bring about the injurious processes named above, difficulty is at once encountered, because of the element introduced into the problem by such things as personal peculiarities, or race peculiarities, which make it impossible to lay down any general rule that shall be applicable to different individuals. In no condition demanding medical treatment must this element receive more careful consideration. The old adage, "What is one man's meat is another man's poison," receives most emphatic indorsement from our experience in connection with the diet which is beneficial, or the reverse, to patients exhibiting the conditions to which we have referred as being those which are productive of renal calculus.

Sugar has been regarded as harmful for gouty and calculous patients. In this connection the following observations of Professor Harley are suggestive and interesting:

"If," said Professor Harley, of London, "sugar is so very harmful to gouty individuals, how does it happen that gout does not exist in any of its manifestations among the women of the Turkish harems, who lead sedentary lives and consume great quantities of sugar and sweetmeats?

"It is true, also, that gout and calculus are exceedingly rare among the negroes of the South, who consume during the sugar-cane season large quantities of sugar."

He mentions, further, the failure of his son and of a friend of his, both of whom had gouty inheritances of three generations, to produce gouty symptoms in themselves by the daily ingestion of as much as eighteen ounces of sugar, which they continued to take for about three months. Each of them had previously had several typical attacks of gout.

While these facts are not conclusive, they are certainly suggestive, and show the difficulty of laying down hard and fast rules with regard to the articles of diet which are or are not harmful.

A large proportion of meat, of nitrogenous foods, and *alcoholic drinks* have been credited with being harmful to this same class of patients. Here, again, however, we encounter such interesting and contradictory facts as these:

Among the natives of certain provinces of India joint manifestations of gout are said not to occur; while, on the other hand, calculous disease is extraordinarily prevalent. These people are vegetarians and abstainers from alcoholic stimulants, and the facts cited are in direct contradiction to the idea expressed above with regard to the injurious influence of meat diet and alcohol; or, at any rate, serve to show that among the natives of this race these factors do not play a part in calculous production, which must be referred to some other cause.

In this connection, the observations of Surgeon Major Roberts,[5] of the English army, are of interest. They show the proportion of cases of calculus among the natives of India with relation to their diet, more especially with respect to the relative numbers of cases occurring in the provinces the inhabitants of which make rice their staple food, as compared with those in which this is not the case. The following table gives the figures reported by Roberts.

It is based upon the number of 3041 operations for calculus performed in the course of one year in India:

	Proportion of population eating rice per mille.	Rate of calculus operations per mille.	Annual average operations.
1. Punjab	52.6	0.078	1482
2. N. W. Provinces and Oudh	90.9	0.021	925
3. Bombay	125.0	0.017	283
4. Central Provinces	333.3	0.011	112
5. Bengal proper	666.6	0.0034	218
6. Madras	333.3	0.00067	21
7. Assam	750.0		

Influence of Defective Excretory Functions.—Of the injurious influence of defective excretion, whether from the lungs, the intestine, the skin, or the kidneys, it need only be said that such waste products as are not properly or fully excreted by the organs charged with that duty are retained in the organism and affect it harmfully, according to the nature and the amounts of the elements thus retained. The conditions under which the failure of proper excretion takes place are numerous. Some of the more practical forms in which we see them are the following: Defective excretion by the skin, owing to neglect of cleanliness or because of extensive skin lesions. Pulmonary disease of sufficient extent will produce the same result with respect to the performance of the excretory office performed by the lungs. Neglect to maintain regularity of the bowel movements and the constipation which results therefrom work a similar evil in the case of the excretory function of the intestines. Finally, disease of the kidney brings about the same result with reference to the excretory function of that organ.

The retention in the system of these products, which results from

ill-performed excretory functions just noted, creates in its turn defective tissue metabolism, and thus brings about through another road those conditions which favor the formation of renal calculus.

Defective Supply of Oxygen.—Besides an insufficient supply of oxygen in the air inhaled, causing a failure of a proper supply of it in the body, the same result may, of course, be brought about by pathological changes in the lungs themselves, of such a character as to render them incapable of receiving enough oxygen, even though the supply of the latter in the atmosphere be ample.

With this failure of the proper amount of oxygen there is a corresponding failure of the combustion which is essential for the production of the completed waste product of normally performed metabolism; or, as one may say, the fire is not hot enough to burn the fuel down to its proper ash.

The same results may be brought about by whatever influences are destructive of the red corpuscles of the blood, such as are seen, for example, in certain cases of anemia.

Insufficient Muscular Activity.—Sluggish circulation of the blood, inadequate expansion of the lungs and inhalation of oxygen, failure to have the skin perspire, insufficient combustion, may all result from a failure of sufficient muscular activity. The degree of muscular exercise which is beneficial, or the contrary, will be spoken of in connection with the treatment.

2. Conditions Local to the Kidney Which Favor the Formation of Calculus.—Ord, Rainey, Carter, and others have demonstrated the presence in renal calculi of a colloid substance, and that it is a component part of the calculi formed in the kidney.

This substance is said to be the product of, or associated with, a desquamative condition of the epithelium of the renal pelvis and calices. The nature and cause of the processes in association with which it appears are not clearly made out as yet. It is believed to play the part of a cement by which the separate crystals become aggregated into minute masses, and later into the nucleus of the stone, and that without the presence of this cement substance, calculous formation does not occur. More recent observations tend to show that this substance exists under normal conditions (Moritz, Mendelsohn, and others), and if this be true, its causal relation with calculus becomes questionable.

Secondary Calculus Formation.—The conditions under which secondary calculus forms are somewhat different. Here the opportunity is offered in cases in which the kidney is affected for the direct influence of bacteria to enter into the production of stone. The role of bacteria in this connection is, in part at least, that of causing decomposition of

the urine and the precipitation of the crystals of some of the alkaline salts.

In cases in which pyonephrosis exists there is still another factor favoring the occurrence of this decomposition, namely, that of partial retention of the urine in the kidney.

In these circumstances the conditions resemble those of the bladder in cases of chronic cystitis and urinary retention of vesical origin, such as prostatic hypertrophy, in which alkaline fermentation of the urine has taken place. The calculi which form in *such* kidneys are chiefly composed of the alkaline salts.

In most instances calculi are made up of alternating layers, sometimes of the oxalates and uric acid or the urates, or again of urates and phosphates, or of the latter and uric acid. When this is the case, it shows that there has been a corresponding alternation of the reaction of the urine from alkaline to acid, or vice versa.

A calculus having a nucleus of uric acid or of oxalates and an outer covering of phosphates shows that it formed originally as a primary stone, and that to its presence are to be referred the subsequent pathological changes in the kidney which produced corresponding ones in the character of the urine; that is to say, from acid to alkaline reaction, and with the latter change the precipitation of alkaline salts which form the outer covering of the stone and give to it the character of a secondary calculus.

Pathological Anatomy.—If calculus remains embedded in the renal parenchyma, the pathological changes referable to its presence may be slight or nothing. If any do occur, they are due to infection of the kidney. In the absence of infection, such calculi increase very slowly, or, after having attained a moderate size, they remain without any change.

Calculi which occupy the pelvis or calices of the kidney, especially if they are movable or migratory, are almost always productive of more or less well-marked pathological changes in the kidney, and invite infection either from the bladder, by an ascending process, or through the blood current. The changes referred to are of the following character:

1. Thickening of the walls of the renal pelvis or calices.

2. Chronic inflammatory processes of the perirenal tissues, or, in the more acute and violent infections, pus formation in the perirenal envelope.

3. Hydronephrosis, in the cases in which there is partial or repeated short-lived total occlusion of the ureter by the calculus, and if infection then occurs, pyonephrosis.

If total obstruction of the ureter occurs, and if it continues long enough, or if it is frequently repeated, the kidney parenchyma is more or less

atrophied or wholly destroyed (Fig. 365). In some cases, pus breaks through into the perirenal tissues; in others, the peritoneum overlying the kidney becomes adherent to it; sometimes the membrane separating the suppurative process from the peritoneal cavity gives way and the septic fluid is discharged into the latter, producing either a local walled-off or a general peritonitis, which almost always proves fatal.

Fig. 364

Pyonephrosis due to renal calculus. Calculi lying in some of the pockets of the kidney.

Fig. 365

Calculus partly occluding the ureter.

Adhesions are often formed around the kidney in consequence of the inflammatory process and its resulting connective-tissue formation. The more important effect of this is to bind the organ to adjacent parts, sometimes fixing it in such a way as to constrict its pelvis or ureter, and again covering the pedicle in such a way as to make it difficult or impossible to isolate and tie it off in the performance of a nephrectomy, and making injury to the vena cava very probable if great care is not taken to avoid it. (See Illustrative Cases, No. 1.)

Symptoms and Diagnosis.—RENAL COLIC.—The so-called renal colic is the most characteristic evidence of the presence of a calculus in the kidney in typical cases. The nature of the attack is as follows:

Sudden pain, beginning usually in the kidney of one side and radiating to the groin in the line of the ureter, generally extending to the testicle, and often shooting along the urethra to the head of the penis. After persisting a variable length of time, the attack ceases abruptly, as it began. This is the case when the calculus has succeeded in passing through the ureter or when it slips back into the renal pelvis after having been, during the height of the pain, pushed into the ureteral orifice of the renal pelvis. If this does not happen, the pain either persists or temporarily subsides, to return again after an interval. The latter conditions probably attend slight changes of position of the stone, such as to cause it to press more or less strongly upon a sensitive part of the renal pelvis or the ureter.

During the height of the crises of pain the patient seeks relief by constantly changing his position, tossing from side to side, or crawling upon hands and knees on the floor.

SYMPTOMS ASSOCIATED WITH RENAL COLIC—*Nausea and Vomiting.*—These frequently attend the attacks of renal colic.

Constitutional Disturbance.—In comparison to the excessive degree of pain there is, as a rule, far less constitutional disturbance in the attacks of renal colic than one would expect. In a few cases there is great prostration; the patient may become unconscious, and marked cardiac depression occurs.

The temperature is normal, unless the kidney is infected, in which case it may be elevated. The same is true of the pulse. Constipation is apt to attend the attacks of renal colic. More or less spasm of the abdominal muscles is also often present.

Urinary Symptoms.—The *most serious* of these is the sudden *diminution* of the quantity of urine, or anuria, during the attacks of pain.

Frequent urination, attended with more or less pain, extending down the urethra, is usually present.

Hematuria.—Except the ureter be occluded by the calculus, more or less blood is usually to be found in the urine.

SYMPTOMS OTHER THAN RENAL COLIC.—*Hematuria.*—The most constant symptom of renal calculus is hematuria. The blood in the urine is often only microscopic in amount. On the other hand, it may be in such large quantity as to form clots in the ureter or in the bladder; the latter have no characteristic shapes; the ureteral clots may assume long, worm-like shapes conforming to that of the canal.

When blood is in microscopic amounts only, valuable information

may be furnished by examining the sediment of the first urine passed in the morning and comparing the number of blood corpuscles found in it with that in another specimen taken at the end of the day, or, better still, soon after the patient has exercised vigorously. The quantity of blood in this specimen will often be found to be greater than in that which has been voided after the night's rest. It must be remembered that the kidneys of some persons bleed on very slight provocation, even when there is no calculus or other pathological process in them.

Pain.—In typical cases, pain is located in the kidney in which the calculus is present. It has been asserted that pain is felt in some instances, not in that kidney, but in its fellow of the opposite side, even though no stone is present in the latter. The direct connection of the nerve supply of the two organs makes this theoretically possible, but we think that convincing clinical evidence is thus far lacking of its actual occurrence in the human subject, if the other kidney is in a normal condition.

Pyuria.—Pus will be present in the urine coming from the kidney in which the calculus exists when that organ is infected. It is most abundant in the cases in which the kidney has become pyonephrotic. If the ureter is blocked by the calculus, there will be a sudden cessation of pus in the urine. This clearing up of a previously cloudy urine is very suggestive. It is still more characteristic, however, of certain other renal conditions.

Crystals, Casts, and Renal Epithelium in the Urine.—One or all of these three elements may be absent or present in cases of renal calculus. They are sometimes lacking and are less reliable evidence than blood is of the presence of calculus in the kidney.

Tenderness on Pressure upon the Kidney.—When present, this is a very suggestive sign of calculus, especially in connection with other evidences of its existence. It is, however, frequently absent. It is elicited by pressing the kidney between the fingers of the two hands when making bimanual examination of the organ, and especially by pressure upon the loin at the point just external to the junction of the last rib and the quadratus lumborum muscle.

Enlargement of the Kidney.—Bimanual palpation will detect a marked enlargement of the kidney, unless the patient is unusually stout, and when present in conjunction with other symptoms suggestive of renal calculus, it is a very significant and confirmatory evidence of the condition.

FEATURES IN ATYPICAL CASES.—*Cases in Which the Symptoms Are Slight or Absent.*—Calculus may be present in the kidney for years without giving rise to any symptoms whatever. The stone may even

destroy the entire renal parenchyma without giving any conspicuous evidence of its existence. (See Illustrative Cases, No. 6.)

The degree of pain and disturbance is often in inverse ratio to the size of the calculus.

Bladder Irritability May Be the Only Sign of Renal Calculus.—The failure to recognize this fact is the chief cause of the numerous errors that occur in diagnosis. The writer has had five patients who presented absolutely no other evidence of renal calculus than this, subjective or otherwise; the urine was normal in each instance until the passage of the calculus, after which, for a short time in all of them, it contained more or less abnormal constituents.

When, in addition to bladder irritability, there is pus in the urine, the liability to mistake the true nature of the condition is increased, and it is very often overlooked, the diagnosis of cystitis being made.

Unusual Sites of Pain.—Instead of in the typical locations, pain is sometimes felt in other situations. Of these, the anterior crural and the sciatic regions are the more common ones; sometimes it is felt in the knee of the same side as that of the affected kidney, and one of the writer's patients had it in the heel. The pain in this case came on some time previous to the passage of the calculi and ceased very soon afterward, on three different occasions.

In other cases the pain may closely simulate that of appendicitis, of pleurisy, or of pneumonia of the lower part of the lung.

X-RAY PHOTOGRAPHY OF RENAL CALCULI.—This is the most positive diagnostic method at our disposal. This does not mean that it is at the disposal of any but those who are especially skilled in the detection of renal calculi by this means, for the sources of error are many and the practice and special knowledge demanded to produce trustworthy plates and to interpret them correctly is too great to give value to the work of any but the most expert workers in this department. Even among these, there is a good deal of difference of opinion as to the possibilities of the radiograph in detecting renal calculi. Kümmel,[6] for example, asserts that he can detect calculi of all sizes and of any chemical composition. Williams, of Boston, on the other hand, says that it is not possible to detect pure uric acid calculi. Leonard, of Philadelphia, who at first believed that all kinds of stones in the kidney could be discovered thus, has since expressed doubt as to the possibility of showing those of pure uric acid. Cole, of New York, holds an opinion nearer to that of Kümmel, though somewhat less positive, and is also very decided as to the liability to make mistakes when interpreting the nature of the shadows in a certain number of instances.

Among the more frequent errors made are those of mistaking for renal

calculi the shadows of fecal concretions, imperfections in the plates, and, in the ureter, the shadows that are probably made by exostoses of the pelvic bones.

Fig. 366

X-ray picture of renal calculus.

Two or more examinations are often made necessary on this account. It is important in cases of renal calculi to know the functional capability of the kidney opposite to that in which the stone lies. To deter-

mine this, it is necessary to have the urine of each kidney to examine separately, and this can be obtained by ureteral catheterization. The phloridzin and cryoscopic tests of the urine, as well as the usual ones for the quantities of the solids and the presence of abnormal constituents

FIG. 367

X-ray picture of renal calculus.

should be made with the urine of each kidney. (See chapter on Examination of the Urine.)

Treatment.—GENERAL CONSIDERATIONS.—1. The fact that renal calculus may be present in some cases for a long time without causing injury of consequence does not justify the assumption that the same

immunity will be enjoyed in any other given case, nor does it excuse the physician who is aware of its existence for his failure to advise its removal. This remains true whether the patient has symptoms referable to the calculus or not.

2. Renal calculus is to be regarded as a menace to the health and to the life of the patient, because of its liability to damage the kidney, to invite renal infection, to cause anuria, to set up perirenal inflammation and suppuration.

3. The fact that a patient has passed one or more calculi, even though he may be free from any subjective symptoms thereafter, does not warrant the assumption that there are no other calculi remaining in the kidney. The *x*-rays should always be employed and urinary examinations continued, in order to be assured of the presence or absence of other calculi.

4. Medical treatment should always be employed for a reasonable time, with the intention of procuring the passage of the stone from the kidney when it is known to be small enough to pass through the ureter. When it is known to be too large to do so, surgical treatment should be applied without delay.

5. After the passage of a calculus medical treatment should be continued until the urine has become normal, and the tendency to form other calculi should be combated.

6. In any case in which medical treatment has failed to cause the spontaneous passage of the calculus after a reasonable time, surgical treatment should no longer be delayed.

The treatment may conveniently be considered under three headings, *Prophylactic, Medical*, and *Operative*.

PROPHYLACTIC TREATMENT.—This comprises measures of hygiene and diet. Under hygiene are included the following:

The Function of the Skin.—The skin cannot properly perform its functions if it is not kept clean and if the circulation of the blood through it is too sluggish. Properly applied bathing secures the one, skin frictions and bodily exercise obviate the other.

If the patient is robust and of the gouty or rheumatic diathesis, Turkish baths twice weekly for a month or so and cold-water bathing on the other days of the week will be beneficial. If, on the contrary, the patient is weak, anemic, and neurasthenic, such a regimen will probably be deleterious. Such a patient should be daily bathed with cool water applied with a soft towel, finishing the bathing by cold water to which is added alcohol in proportion of one part to ten of water, and, after drying the skin, employing friction with a hair cloth. A rest of fifteen minutes afterward is desirable.

Exercise.—Exercise should be adapted to the strength, muscular development, and previous habits of exercise in each individual case. It should be begun moderately and never carried to excess. The best measure of excess is that furnished by the patient's own feelings. If the exercise exhausts, it is too much; if it gives a feeling of well-being, it is probably right. Exercise should be made as great a pleasure and as little of a task as possible. Massage is an excellent substitute for exercise in the cases of patients who, for any reason, cannot take the latter.

Hours of Sleep.—*Regular* hours of sleep are quite as important as *enough* sleep. Seven or eight hours is a good average amount of sleep for the individual with lithemic tendency. More than this is apt to be injurious to these patients.

In the cases of oxaluria and phosphaturia with which anemic and neurasthenic symptoms are associated, longer hours of sleep are usually desirable.

Supply of Oxygen.—As much fresh air, sunlight, and good ventilation of dwelling quarters as can be secured should be provided for these patients. They should sleep in a well-ventilated room, with the windows open.

Change of Occupation and Circumstances.—Occupations demanding too many hours of continuous work, work in bad atmospheres, work involving great mental anxiety, and overexcitement, are conditions all of which are deleterious to patients of this class.

Diet.—(See remarks upon this subject under Etiology.) No general rule applicable to all persons can be laid down with regard to diet in cases of renal calculus. Every individual should be studied, and the diet should be adapted to each person, not the person to a standard diet list.

The list which follows contains the articles of diet which should be avoided by patients with marked uric acid diathesis, but it is to be understood that it is not to be rigidly adhered to or indiscriminately applied to everyone.

Articles of diet to be avoided:

Soups.—Tomato, black bean, pea, and mock turtle soup.

Fish.—All fried and canned fish, mackerel and salmon.

Meats.—All fried, canned, and smoked meats; ham, tongue, veal, corned beef, and pork.

Vegetables.—Fried and canned vegetables, cabbage, cauliflower, turnips, onions, cucumbers, radishes, and tomatoes.

Fruits.—Pears, grapes, bananas, cherries, all berry fruits except blackberries and plums.

Sweets.—Cakes, rich puddings and pastry, candies, preserves, syrups, jams, etc. (Reduce sugar to a minimum.)

Miscellaneous.—Oatmeal and all but the most delicate cereals; nuts and raisins; pickles, peppers, spices (the latter except in moderation); vinegar; rich sauces.

Drinks and Beverages.—Wines and liquors, especially malt liquors and champagne. (Good whisky, well diluted, is the least harmful stimulant.) Café au lait, chocolate.

Non-alcoholic Drinks.—Tea is, as a rule, preferable to coffee, especially if it is taken with lemon, in the Russian fashion, instead of with cream. Café au lait is frequently injurious to patients of this class. Chocolate is not well borne by persons of gouty or rheumatic tendency. The modified forms of it, such as broma, cocoatina, and the decoctions of cocoa nibs or shells, especially the two latter, are apt to be beneficial and to exercise a marked diuretic effect.

Alcoholic Drinks.—In general, it may be said that patients of gouty or rheumatic tendency and those with uric acid diathesis are better without alcoholic stimulants of any kind. This does not mean that it is well to cut them off suddenly in all cases; on the contrary, to do so with patients who have been habituated to them for many years is a mistake, and sometimes a dangerous one. If they are taking an undesirable form of stimulant, substitute one which is not so, for example, a good quality of whisky well diluted with soda or potash water.

Malt liquors are almost, without exception, harmful to the patients of the class we are considering. Next to them, champagne is injurious. Nevertheless, there are some persons with whom the lighter grades of champagne agree better than any other wines. (There is a general belief that the "Brut" champagnes contain less sugar than others. This is by no means true, and some of them contain a large proportion of free acetic acid, which is distinctly harmful to these patients.)

One of the best recipes for acquiring gout or rheumatism is said to be that of leading the life of a London longshoreman. The men of this class are wet most of the day and stand long hours in the cold water. At intervals they leave it to go into neighboring taverns and drink strong, bitter beer.

In cases of phosphaturia in which the patients are weak, thin, anemic, and neurasthenic, a moderate amount of stimulant is often beneficial.

In all cases, no matter what may be the nature of the diathesis, the patients should drink enough water to bring the urine up to its normal quantity or a little above it.

MEDICAL TREATMENT.—*Mineral Waters.*—As Sir Henry Thompson[7] pointed out long ago, the use of the pharmaceutical preparations of the

same salts which are contained in certain of the mineral waters deprives them of the valuable properties which they possess when taken in their natural medium; that is to say, in the mineral water itself.

The salts of these waters which are thought to be especially beneficial are the sulphate of soda and the sulphate of magnesia. The waters possessing the largest proportion of these are the Pullna and Hunyadi Janos; these are very nearly alike with respect to the quantities of the two salts named above. Sir Henry's objections to the first was on account of its being too active a cathartic, and because of its griping effect. Next in order to the two waters just mentioned with respect to the proportion of sulphates is Friederichshall. This is a milder agent, so far as its laxative properties are concerned, and on this account is better suited for prolonged use than either of the others. It also has the advantage of being less disagreeable to the taste. The average patient will find half to three-quarters of a tumbler of this water sufficient to secure one thorough movement of the bowels daily. The water should be taken on waking and at least half an hour before anything is eaten; half a tumbler of water as hot as it can be comfortably swallowed should be taken immediately after the mineral water. The moderate degree of catharsis which is obtained by the employment of this or the Hunyadi water can be maintained for a considerable period. We are in the habit of directing the patients to take Friederichshall water in the doses just mentioned, continuously for three weeks, then to omit it for the next week or two, and resume it again for another course of three weeks.

The waters of Carlsbad have but a moderate amount of the sulphate of soda and contain a large quantity of the carbonate of soda. Vichy and Vals waters contain but an insignificant proportion of the sulphate and a very large one of the carbonate of soda.

In connection with the treatment by mineral waters, it may be said that much of the benefit derived from them is due to the fact that the patients who go to the "cures" live in a hygienic manner; all follow the same regimen, and, consequently, do not fail to thoroughly apply the treatment in a broad sense; whereas if they remain at home and endeavor to do so, the treatment is usually carried out in a capricious and incomplete way, and little if any benefit results from it.

The Carlsbad treatment is rather depleting, and, consequently, is not appropriate for weak and anemic patients. It is especially suited to the robust, full-blooded type of patient with the uric acid diathesis.

A short course of the ferruginous waters is often of value, following the "cures" of which we have been speaking. Schwalbach and Schlangenbad have held deservedly high reputations as places in which such "after-cures" are carried out.

Medicines.—There are two medicines which seem to us to possess marked value in the treatment of lithemia and renal calculus. These are calomel and turpentine; the former is of much service in securing free catharsis at the outset of the treatment, for which purpose it should be given in full doses once or twice in the course of the first week; thereafter, as occasion may arise, it may be advantageously administered for a longer period in small quantities at bedtime, Hunyadi or Friederichshall water being used to supplement it, on waking in the morning. Used thus in one-sixth to one-quarter grain doses, it may be continued daily for a week at a time.

Turpentine.—Somewhere in the course of that excellent memoir, *Pepy's Diary*, there occurs this remark, or its equivalent: And at this season we go to Tunbridge Wells to drink the waters and to get rid of our gravel, to which end we are aided by taking small doses of turpentine. Ralfe[8] refers to the use of turpentine thus, "Although soft water relieves this condition [retention of calculus in the renal pelvis or ureter], we have a more rapid and sure agent in turpentine." He quotes the report of Dr. Henry of a case in which a single dose of the drug brought away an enormous quantity of uric acid sand and concretions from the kidney. Continuing, he adds: "After a few doses, even if the calculus does not pass, the patient becomes easier and the urine less purulent, whilst in many the administration is followed by the discharge of the concretion. It is valuable, too, as a prophylactic agent, since, whilst it renders the urinary passages more free, by diminishing the excessive amount of mucus and the swelling of the mucous surface, it removes the conditions favorable for the retention and growth of a subsequent nucleus."

In the writer's own experience, no drug has been comparable with turpentine for the excellence of the results obtained in these respects. This is true of the remedy when used alone, but its effect seems to be augmented if it is combined with the following additional measures:

The patient is directed to remain absolutely at rest for the first two or three days of the treatment; if renal colic should occur, to take hot hip baths morning and night, to drink freely of Poland water, or of any other pure water; to take a milk diet, with the exception of a little broiled fish at mid-day and dry toast twice or thrice daily. Milk is to be taken in the following manner: Not less than two quarts in each twenty-four hours; not to be swallowed quickly, but sipped slowly; not to be taken cold but slightly warmed, the milk to be diluted with Vals water in proportion of five parts of the former to one of the latter. Spirits of turpentine to be given in 10-minim doses in gelatin capsules thrice daily.

Turpentine should not be continued for longer than a week continuously, nor should it be given in larger doses than stated above, else it

may give rise to glomerulonephritis. All of these measures should be discontinued, of course, when the calculus has passed.

In cases of oxaluria, especially if associated with anemia, the use of iron and of dilute nitromuriatic acid in moderate doses is helpful.

In cases of phosphaturia, the precipitation of the amorphous phosphates can be interrupted almost invariably by the administration of 10-minim doses of dilute phosphoric acid in carbonized water taken thrice daily with meals. It is well to do this from time to time, although the use of the drug will not effect a *cure*.

TREATMENT OF RENAL COLIC.—The object aimed at in the treatment of renal colic is to stop the pain and to relax ureteral spasm.

The best means of combating the pain of renal colic, we think, is by the administration of morphine and the inhalation of ether in combination, rather than by the use of either one alone. The dose of morphine that is large enough to overcome the pain, if morphine alone is relied upon for the purpose, may prove to be a dangerous overdose if the pain suddenly ceases, as so often happens when the calculus escapes into the bladder. The prolonged use of ether, if that alone be relied upon to combat the pain, may be injurious to the kidneys, because of the harmful action which is believed by some observers to be exercised upon the renal epithelium by the anesthetic. A moderate dose of morphine, supplemented by the moderate employment of ether, from time to time, when the pain attains its height, avoids the objections just stated.

Local Application of Heat.—This is best applied by letting the patient sit in a hip bath of water as hot as can be comfortably borne. If the means are not at hand for doing this, hot compresses should be substituted for it.

Massage of the Abdomen.—Manipulation of the abdomen from above downward in the line of the ureter may be applied for the purpose of aiding the passage of the calculus. If the pain caused by this procedure is too severe, ether anesthesia may be administered.

Ingestion of Water.—Water should be freely drunk during the attack of renal colic.

Medicines.—Turpentine is the only one that has seemed to us to be of value. The method of administration has already been described, and the precautions to be observed in taking it.

OPERATIVE TREATMENT.—(For description of surgical technique see chapter on Technique of Operations on the Kidney.) *Indications for Surgical Treatment.*—1. The knowledge that a calculus too large to pass through the ureter spontaneously exists in the kidney.

2. The failure of medical treatment employed for a reasonable length of time—one to two months—to secure the passage of calculus, *even*

though it is known to be small enough to pass spontaneously nto the bladder.

3. Frequently repeated attacks of renal colic which medical treatment fails to relieve.

4. The knowledge that there are calculi in both kidneys.

5. The presence of pyelitis or pyonephrosis.

6. The occurrence of oliguria or anuria. (See under heading of Calculous Anuria.)

The operative measures employed in cases of renal calculus are as follows:

(1) Nephrotomy. (2) Nephrolithotomy. (3) Pyelotomy. (4) Ureterotomy. (5) Nephrectomy. (6) Secondary nephrectomy.

The object of operative treatment is, if possible, to secure the removal of the calculus from the kidney or ureter and to reëstablish a free outflow of urine from the organ if it has been obstructed.

Nephrotomy and the establishment of a renal fistula will be discussed under the heading of Calculous Anuria.

Nephrolithotomy.—One of the earliest, if not the first, operation for removal of calculus from the kidney was performed by the late Dr. William Ingalls,[9] at the Boston City Hospital, October 8, 1872. The case was reported by the operator in the *Boston Medical and Surgical Journal*, March 25, 1882.

Morris[10] refers to the publication of the report of his first operation. This operation, which he claims as being the first nephrolithotomy ever performed, was done by him in 1880, eight years after Ingalls' operation. Morris' claim, while not in accordance with the facts, was one which he had every right to put forward, inasmuch as Ingalls did not report his case until a year later.

Newman[11] refers to an operation for the removal of stone done by Durham in 1872.

Nephrolithotomy has for its object the removal of calculus from the kidney through an incision made in the organ, preferably parallel with, and about a quarter of an inch posterior to, the highest part of the convex border. In cases in which the calculi are not large, the operation presents no especial difficulties, as a rule. In those in which the contrary is the fact, in which the calculus sends branches into the calices, or in which it is adherent, as it so often is, to the renal substance, it is, or may be, a very difficult operation, and is sometimes dangerous. The danger lies in the liability that exists in the latter class of cases to cause serious bleeding by lacerating the kidney or one of its larger bloodvessels when removing the calculus. Such a hemorrhage may necessitate the immediate performance of nephrectomy as the only means of arresting the bleeding.

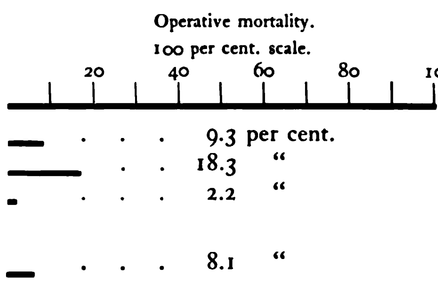
The operation may prove to be *unsuccessful* in some instances, owing to the existence of a large number of small calculi scattered throughout the kidney and its calices, or lying in little pockets which they have made for themselves and in which it is almost impossible to find them. It is sometimes far from easy to find even a stone of considerable size, and although the certainty of its existence may be established by a perfectly convincing *x*-ray picture, it may require a long time before the operator succeeds in detecting it, even when he has split the kidney open from end to end. It is extraordinary how large a stone may escape detection by the sense of touch, by the use of a probe, or a needle.

The approach to the kidney for the purpose of removing calculus should, with but few exceptions, be through the loin. In some instances the lumbar incision will have to be supplemented by a second one in order to obtain more room. These details are dealt with more fully in the chapter on the Technique of Operations on the Kidney.

The mortality attending nephrolithotomy is very small in cases in which the kidneys are not infected, and high in those in which they are infected. In the subjoined table of cases collected by the writer, consisting altogether of 307, there were 222 in which the statement as to infection or non-infection was definitely made. The non-infected cases numbered 135 and the infected ones 87. The respective mortalities of the two were 2.2 per cent. and 18.3 per cent.

TABLE I.—NEPHROLITHOTOMIES.

Operators.	Cases.	Deaths.	Operative mortality.
Kümmel	57	8	(Seven of these fatal cases were of bilateral calculus.)
Morris	34	1	
Herczl	29	3	
Kelley	25	3	
Ransohoff	23	1	
Cabot (H.) (Massachusetts General Hospital cases)	21	4	
Cunningham (Boston City Hospital cases)	19	3	
Tuffier	18	0	
Jessop	14	0	
Watson	14	0	
Series of less than ten cases	55	5	
	309	29	9.3 per cent.
Kidneys infected	87	16	18.3 "
Kidneys not infected	135	3	2.2 "
	222	19	
Fistula following			8.1 "



INDICATIONS AND CONTRA-INDICATIONS FOR PRIMARY NEPHRECTOMY.—*Indications.*—1. Such destruction of the kidney as to make it obvious that it can no longer perform a useful degree of functional work.

2. Extensive suppuration which probably cannot be overcome by palliative treatment if nephrolithotomy only were done.

3. Obstruction of the ureter which cannot be remedied by plastic or other conservative operations.

Contra-indications.—1. Dangerous condition of the patient.

2. Ignorance of the functional capability of the other kidney.

3. When the kidney in which the calculus lies is found to be in a sufficiently good condition to perform useful functional work.

Secondary Nephrectomy.—If, for any reason, a primary nephrectomy is contra-indicated in a case in which it is, nevertheless, desirable to have the organ removed (because of suppuration, etc.), secondary nephrectomy may be performed later, except in the presence of one or another of the contra-indications stated above.

Indications for the Performance of Secondary Nephrectomy.—These are: 1. Distress caused by renal fistula, if it cannot be overcome by the employment of a mechanical contrivance that will give the patient comfort and freedom to lead an active life.

2. Prolonged renal suppuration which cannot be benefited by supplying free drainage to the kidney.

3. Failing health and strength, if due to the renal condition.

4. Recurrence of calculus, if there is also but little functionally capable renal substance left in the kidney.

There must be, as already stated, assurance that the other kidney is functionally capable before removing its fellow.

Suppuration in the kidney is always a menace, unless free drainage is afforded; when that is supplied there is comparatively little danger from it, as a rule.

A permanent renal fistula *need* not be a source of such distress to the patient as to make it imperative to remove the kidney, provided the surgeon knows how to arrange the drainage properly. (The method of doing this, devised by the writer, is described in the chapter on the Technique of Operations on the Kidney.)

The following table gives the operative mortality accompanying primary and secondary nephrectomies in two series of cases of renal calculus:

TABLE II.—NEPHRECTOMIES.

PRIMARY.

Operators.	Cases.	Deaths.
Schmieden (collected from the literature)	89	31
Kümmel	18	2
Morris	17	5
Hagman	5	2
Nicolich	7	1
	136	41

Operative mortality, 30.1 per cent.

SECONDARY.

Cases.	Deaths.
33	6 or 18.1 per cent. operative mortality.

CALCULOUS ANURIA.

Etiology.—1. The blocking of the ureter of a solitary kidney by calculus.

2. The simultaneous blocking of the ureters of both kidneys.

3. The blocking of the ureter of one kidney, the other kidney being functionally incapable.

4. The blocking of the common stem of two ureters when they are fused or of the single ureter of a fused kidney.

5. The blocking of the ureter of one kidney and the suppression of the function of the other kidney by "reflex" influence, the latter organ being normal or but moderately diseased.

The occurrence of the last of these ways of bringing about anuria is denied by many observers. That it may occasionally occur seems to be proved by a few cases in which the other kidney has been found, postmortem, to be normal on careful microscopic examination; and from the evidence afforded by the clinical observations in at least seven cases in which the urine drawn from the unobstructed kidney by ureteral catheter after the cessation of the anuria, was perfectly normal; and by the results of some experimental work with animals. Götzl, for example, succeeded in producing complete suppression of the renal function of the opposite kidney by suddenly increasing the intrarenal pressure in its fellow. This result was obtained in 2 out of 12 dogs. Some other experimenters have failed to obtain the same result, however.

Results of Sudden Total Occlusion of the Ureter.—When this happens the following phenomena take place:

1. Increased intrarenal pressure.

2. Congestion and œdema of the organ, under the influence of which it becomes enlarged.

3. Rapid diminution in the urinary secretion and change in its chemical nature, the latter consisting in a great diminution of its solid constituents.

4. When the obstruction has lasted for about forty-eight hours or so, destructive changes begin in the renal epithelium and in the glomeruli. Unless the obstruction be relieved these changes continue to advance. If long continued, total destruction of the organ results.

5. If the kidney is already, or becomes, infected, these destructive changes proceed more rapidly than when it is not infected.

6. The degree of functional capability that is retained by a kidney that has been thus obstructed cannot be determined by inspection of its substance at the time of operation upon it, for the functional power that may remain is dependent upon the extent of the processes of microscopic nature in the renal substance, and these may be very extensive in a kidney which still has a relatively thick layer of *apparently* capable secreting substance, while in another which has but a very thin strip of the renal substance the microscopic destructive changes may be as yet but very slight in extent. The latter kidney would, to all appearance, seem to be far less capable of carrying on a useful degree of its function than the other, and yet the contrary might be the fact.

7. The only means by which the functional capability of such kidneys can be estimated is by testing the urine coming from them after they have been relieved of the obstruction. This cannot be determined at once, however, for the renal function may improve for as long as six months after the renal retention is relieved.

The results of partial obstruction of the ureter, or of complete, repeated, but short-lived occlusion, are: distention of the renal pelvis primarily; later, of the calices and of the kidney itself, followed by atrophy of its substance, produced by increased intrarenal pressure. The condition known as hydronephrosis is thus brought about. If such a kidney becomes infected, pyonephrosis results. Pousson[12] and Morris[10] have called attention to the fact that the presence of hydronephrosis of the kidney which becomes obstructed by a calculus, with resulting anuria, seems to be, in a measure, a safeguard against uremia, its prolonged absence having been strikingly shown in some of the cases reported, to which these authors refer.

The Period of Tolerance.—The interval between the beginning of anuria and the occurrence of uremic manifestations is called "the period of tolerance." Its length is, in some instances, remarkable. It has been prolonged for sixteen days. The writer found its average duration in 62 cases which he collected from the literature of the subject to be between five and six days. In but 4 of the whole number was it as short

as twenty-four hours. There were 14 cases in which it lasted from ten to sixteen days.

The remarkable *immunity* from *uremic poisoning* exhibited in these cases lacks satisfactory explanation. A plausible theory is that it is due to the influence of the *internal secretion* of the kidney. It is assumed that in the performance of this second of the functions of the organ substances of unknown nature are formed in the kidney and are returned to the organism through the renal vein, which substances appear to have as one of their properties an inhibitory influence with respect to uremic poisons, and also to help maintain the general nutrition and to make the individual more resistant to the action of those poisons. The experiments of Vitzou are of interest in this connection. (See section on the Physiology of the Kidney.)

Duration of Anuria.—The writer has collected and analyzed 205 cases of calculous anuria with reference to various aspects of the subject. The following data appear with regard to the duration of anuria:

Of the whole number, the duration of anuria was stated in 101; 62 of them were treated expectantly; the duration of anuria in these was as follows:

TABLE III.—DURATION OF ANURIA IN CASES TREATED EXPECTANTLY.

TWENTY CASES IN WHICH RECOVERY TOOK PLACE.

Duration of anuria.	Cases.
Less than 48 hours	1
To end of 48 hours	1
" " 4th day	1
Between 5 and 7 days	8
" 7 " 10 "	3
" 10 " 15 "	6
	20

FORTY-TWO CASES ENDING FATALLY.

Duration of anuria.	Cases.
4 days	1
5 to 8 days	15
8 " 12 "	14
12 " 16 "	11
23 days	1
	42

Duration of Anuria in Cases Treated Operatively.

Ninety-five patients were treated operatively. The duration of the anuria was stated in 39 of these cases, and was as follows:

DURATION OF ANURIA IN THE TWENTY-SIX CASES ENDING IN RECOVERY.

Days.	Cases.
1	2
2	2
3	2
4	2
5	2
5 to 8	9
8 " 11	2
11 " 15	5
	26

DURATION OF THE ANURIA IN THE THIRTEEN FATAL CASES.

Days.	Cases.
2	2
4th and 5th	2
6th " 7th	4
8th " 9th	2
12th	1
14th and 15th	2
	13

A point of much importance in connection with the manifestation of uremic symptoms and the period of tolerance is that in a good many cases uremia occurs suddenly, and while the patient's condition has given no warning of it. It is, therefore, impossible to predict at what moment uremia may take place. As Mr. Morris has wisely said, "In these cases uremia is always imminent." It should also be noted that death has occurred suddenly in some instances without any uremic manifestations having preceded it, or other sign that forwarned those in attendance that it was likely to happen.

Treatment of Calculous Anuria.—The treatment of renal calculus with anuria differs from that in cases without anuria because of the greater gravity of the condition, which does not permit temporizing. We are, moreover, deprived of the aid that is derived from the knowledge of the functional capability of each of the kidneys as determined by means of the ureteral catheter and the tests of the urines of each kidney separately, because the secretion of the organs is suppressed. In many cases we are unable to use the *x*-rays for the purpose of locating the stone, and are, consequently, obliged to rest the diagnosis upon the physical examination by palpation; the history of preceding renal colics; the chance of detecting a calculus impacted in the mouth of the ureter by the cysto-

scope, and upon finding a calculus in one of the ureters by the passage into it of a wax-tipped or ordinary ureteral catheter.

When the condition of the patient allows the use of the last two diagnostic measures, and if a skiagraph can be obtained, all three means should be employed to determine in which ureter or kidney the calculus is located, or whether there are calculi on both sides. Tenderness of the kidney on pressure and enlargement of the organ are the more important of the physical signs indicative of the presence of calculus.

Certain indications are clear and essential to have fulfilled in connection with the treatment of calculous anuria. The following are the most vital of them: (1) The longer operation is delayed after the beginning of anuria; the smaller will be the percentage of recoveries. (2) The mortality in cases in which operations have been undertaken after the occurrence of uremic symptoms is much higher than that in which they have been performed prior to their appearance. (3) It is impossible to predict the moment at which the period of tolerance may terminate and be replaced by uremia. (4) In a few cases death has occurred suddenly without being preceded by uremic manifestations.

It is evident from what has just been said that it is unsafe to delay operative intervention because of the absence of threatening symptoms, or because of the fact that some of the patients—a very small proportion—have recovered under expectant treatment, after very long periods of anuria. The comparison of the results of the expectant and of the operative treatment which follows furnishes a striking confirmation of the truth of what has just been said.

The data here presented are derived from an analysis of 205 cases of calculous anuria, to which we have already referred, and were taken from the following sources by the author:[13] 181 of the cases are included in the three following writings: Morris,[10] Schenck,[14] Tenney.[15] In addition there are 24 other cases collected by the writer from the literature and not included in the three writings just mentioned classified by the writer as follows:

	Cases.	Deaths.	Mortality (p. c.).
Treated expectantly	110	80	72.7
Treated operatively	95	44	46.3
Total number	205	124	

Nature of operations.			
Lumbar nephrotomy or nephrolithotomy	65	40	
Ureterotomy	15	4	
Pyelotomy	5		
Exploratory incision of kidney	5		
Nephrolithotomy upon solitary kidney	5		
	95	44	46.3

The 5 cases in which nephrolithotomy was done upon a solitary kidney without a death are of especial interest. They are as follows:

1. (McArthur.[16]) A calculus was removed from the *right* kidney by lumbar operation. Secondary nephrectomy. Anuria followed the latter operation, because of a calculus which wholly obstructed the *left* ureter. Nephrotomy was performed upon that kidney. Patient recovered.

2. (Nicolich.[17]) Calculous anuria in a tuberculous kidney. The other kidney had been removed some time before, because of its being tuberculous. Nephrotomy done on the fifteenth day of the anuria. Recovery.

3. (Chevalier and Mauclaire.[18]) The patient had but one kidney. Calculous anuria. Nephrotomy on the fourth day. Recovery.

4. (McKay.[19]) Pyonephrosis of the left kidney. Nephrectomy. Later, calculous anuria from blocking of the ureter of the remaining kidney. Nephrolithotomy. Recovery.

5. (Ferguson.[20]) Nephrectomy, followed by anuria from blocking of the ureter of the remaining kidney. Nephrolithotomy. Recovery.

In addition to the above cases are the 4 following, which show that even in desperate circumstances the condition may not be hopeless:

Chevalier, Duret, Championnière, and Desnos each 1 case. Anuria present for fourteen, ten, thirteen, and twelve days, respectively. In 3 of the cases the patients were almost comatose at the time of operation, and all had very marked uremia. These 4 patients recovered after nephrolithotomy on one kidney, followed, after an interval, by the same operation upon the second one.

How Long May Operation Be Delayed?—There is no instance of death having occurred in less than forty-eight hours from the beginning of the anuria in the series of cases from which the above data have been drawn. There were 6 cases in which the "period of tolerance" was two days or less. It *may* be justifiable, in the absence of uremic symptoms, to delay operation as long as forty-eight hours from the appearance of anuria. Longer than this, we cannot think it should be postponed, and in the majority of cases it should not be withheld as long as that. In any case in which it has been shown by an *x*-ray examination that there is a calculus of the kidney or ureter too large to be passed spontaneously, operation should be done just as soon as it is possible to do it. The same is true in all cases in which uremic symptoms appear before the expiration of the time during which it may have been decided to try the effect of palliative measures.

PALLIATIVE TREATMENT.—During the interval of waiting before operation is undertaken, the following palliative measures should be applied: hot hip baths, sweating produced by heat and (or) pilocarpine, subcutaneous or rectal saline solution injections, and manipulation of the abdomen from above downward along the line of the ureter, with a

view to aid the passage of the stone, giving the patient primary anesthesia if necessary to relieve pain.

THE OPERATIVE METHOD TO BE SELECTED.—It should be borne in mind that the indication to be fulfilled before all others is to restore the suppressed urinary function of the kidney. The most prompt and direct way to do this is by a quickly performed lumbar nephrotomy. It goes without saying that the calculus should be removed from the ureter or kidney at the same time, provided it can be done without so prolonging the operation or making it so extensive as to endanger the patient's life; but it should always be remembered that the one great object of operative interference in these cases is to lay open the kidney and thus to supply relief to its congested condition and a free avenue of escape for the urine. The removal of the stone, though important to have accomplished, should only be attempted if it does not add to the danger of the situation. *The calculus can be dealt with later; the incision of the kidney and restoration thereby of the secretory function of the organ are immediately imperative.*

Closure of the Renal Incision.—Even if the calculus has been removed, and unless we are *positively* certain that there is an entirely free passage for the escape of urine through the ureter, the kidney incision should not be closed entirely. If it is done under any other conditions than these, the risk is incurred of putting the patient in the same danger from which we have endeavored to save him. The risk of establishing a renal fistula by a few days of drainage of the kidney through the lumbar incision is small, and, such as it is, should be taken rather than to run any chance of not maintaining the open road for the escape of urine which has been secured by the operation.

The establishment of a renal fistula is necessitated, of course, whenever the calculus cannot be removed from the spot at which it is obstructing the urinary outflow. (For technique of renal drainage see chapter on the Technique of Operations on the Kidney.) The question of renal fistula will be discussed under a separate heading farther on in this chapter.

Incision of the Second Kidney.—In cases in which there has been no opportunity to make an x-ray examination there is always the chance that there may be an undetected calculus lodged in the ureter of the other kidney. The condition of the one which has been already incised, and from which, or from the ureter of which, a calculus has been taken, will, in a great many cases, be more or less diseased. When the damage of that organ has been so great as to make it very questionable if it is capable of sufficient functional activity to maintain the life of the individual, there will be a corresponding probability that our operation will not have liberated enough kidney tissue of functional capability to sustain life.

It is true that we cannot determine with certainty from the thickness or thinness of the layer of renal substance seen at the time of the operation

the degree of functional capability that may remain in the organ, but we can make a fairly good guess at it, and it is true, at any rate, that the less the renal substance and the more marked the suppuration in it, the less functional work will the organ be capable of performing, and the greater the destruction seen to have taken place in the first kidney operated upon the greater the chance will be that the opposite kidney will have a serviceable amount of functional capability. If, then, the first organ operated upon is, in the operator's judgment, probably functionally inadequate to sustain life, the second one should be at once operated upon, instead of waiting until an interval has passed.

This proposition lacks the support of clinical experience, and must await that confirmation before being accepted. There are but very few cases in which both kidneys have been laid open at the same time in calculous anuria.

BILATERAL RENAL CALCULUS.

The dangers of renal calculus are seriously increased when both kidneys are involved. This is largely because of the greater probability of the occurrence of anuria, and of the fact that both the kidneys are being injured, and, consequently, to the correspondingly greater loss of functional renal capability. Finally, because of the likelihood of having both kidneys infected and the greater danger arising from that fact.

The treatment which is usually applied when *any* operation is performed in these cases is to operate upon *one* kidney, extract the stone, and, if the patient survive, to remove the calculus from the opposite kidney at some later time.

In an article by Kümmel,[6] in which were included the reports of 16 cases of bilateral renal calculus, he comments upon one feature which is of much interest and which is one of a number of factors which go to strengthen the views of the author with regard to the advantage of operating upon both kidneys at one time instead of doing a unilateral operation, as is the usual custom.

The comment of Kümmel referred to is to the effect that in some of his cases of bilateral calculus—in all of which an interval intervened between the performance of the first and the second operation—there was a failure to improve the patient's general condition by the first operation, and that remarkable and rapid improvement followed the second one.

In 2 of the cases to which this comment was applied there was anuria; in 6 others, anuria was not present. In the cases of bilateral calculus without anuria, as well as in those with it, there is no reason why both kidneys should not be operated upon at the same sitting, instead of with an interval between the two operations. Why should further destructive changes be allowed to take place from the continued presence of the

calculus in the second kidney, and why should we not give the patient the whole available secreting renal substance he possesses at once instead of bit by bit? Kümmel's comment, quoted above, may be appropriately recalled in this connection. In Table IV there are set forth the results of 32 operations in cases of bilateral renal calculus.

TABLE IV.—OPERATIONS DONE IN CASES OF BILATERAL CALCULUS.

Operators.	Cases.	Nature of operation.	Results.	Remarks.
Chevalier.	1	Unilateral nephrotomy.	R.	Anuria 14 days.
Championnière.	1	" nephrolithotomy.	R.	" 13 "
Deaver.	1	Nephrolithotomy on one kidney; 18 days later, nephrectomy on same one; nine months after this, nephrolithotomy on other kidney.	R.	
Deansley.	3	1. Nephrolithotomy on one kidney; two weeks later, same on the other.	R.	
		2. Unilateral nephrolithotomy; no operation on second kidney.	R.	
		3. The same.	R.	
Desnos.	1	Unilateral nephrolithotomy.	R.	Anuria 12 days.
Duret.	1	" "	R.	" 10 "
Delbet.	1	Unilateral nephrolithotomy; same one year ater on other kidney.	R.	First kidney hydronephrosis; second, pyonephrosis.
Kümmel (5 with and 11 without anuria).	16	5 with anuria; unilateral nephrolithotomy; later, the 2 patients who recovered were operated upon and recovered.	3 D. 2 R.	
		11 without anuria; unilateral nephrolithotomy; second kidneys done after a interval in each case.	4 D. 7 R.	
Grohe.	1	Unilateral nephrolithotomy; second kidney same, 15 days later.	R.	
Mixter.	1	Same; second kidney six months later.	R.	
Tuffier.	1	Same; second kidney twice at intervals.	R.	
Verdil.	1	Same; calculus passed later spontaneously from other kidney.	R.	
Watson.	2	Simultaneously performed bilateral nephrolithotomy in both; 1 patient anuric, 1 not.	1 R. 1 D.	
Young.	1	Unilateral nephrotomy.	D.	
	32	Deaths, 9, or 28.1 per cent. mortality (40 per cent. mortality in the 10 cases with anuria).		

Conclusions with Regard to Treatment of Renal Calculus with Anuria.—1. In cases of presumed *unilateral calculus*, if it is not known that the stone is too large to be passed spontaneously, palliative measures are justifiable for thirty-six or perhaps forty-eight hours, if no uremic manifestations occur in the meantime. If it is known that the calculus is too large to pass spontaneously, or if uremic symptoms appear at any time, immediate operation is demanded.

2. In cases of *bilateral calculus*, under the same conditions as those just stated, the delay should be less long, or there should be none at all before operating.

3. In cases of bilateral calculus, the first kidney to be operated upon should be that in connection with which the symptoms have been of most recent date in their inception and in which the most recent attack of renal colic has occurred.

4. When possible, without prolonging the operation too much, the calculus should always be removed from the ureter or from the kidney. If this demands too much time it should be done later.

5. Whenever possible, *x*-ray examination should be made of both kidneys before operating. Also, cystoscopic examination of the bladder for the purpose of detecting a calculus should it be lodged in the orifice of the ureter.

6. In cases of either bilateral or unilateral calculus, if the kidney first incised is seen to be so far destroyed as to make it very improbable that this organ by itself will be capable of sufficient functional activity to sustain life, the kidney of the other side should be exposed and incised *at once*, rather than after an interval. If the contrary is true, an interval may be allowed to intervene between the two operations in cases of bilateral calculus, when the patient's condition is such as to make the immediate operation upon the second kidney undesirable; but if this is not the case, the latter should be done at the same time with the first one.

The Treatment of Calculus Impacted in the Ureter without Anuria.—Calculus impacted in the vesical orifice of the ureter has been successfully removed by Young[22] in one case by pushing it out of the ureteral orifice with the tip of a ureteral catheter, which was guided by the view afforded by the cystoscope, in which it was used. The calculus was not very firmly impacted, evidently, in this instance, else it would not have been possible to dislodge it by such means.

Calculus impacted in the lower segment of the ureter may be approached in one or another of the following ways:

Intraperitoneally.—By the extraperitoneal routes: (*a*) from the inguinal region; (*b*) by the so-called pararectal operation; (*c*) by the

lumbo-abdominal incision and by stripping up the peritoneum and exposing the ureter; (*d*) from the perineum; (*e*) through the rectal wall; (*f*) by the sacral route.

In the cases in which the stone is lodged in the lowest part of the ureter, it may be attacked from within the bladder.

Young gives the following summary of the results obtained by the different methods up to the time at which this article was written—1902—as follows:

	Cases.	Result not noted.	Recovered.	Died.
Intravesical route	9	3	6	
Prerectal (perineal) route	1	..	1	
Intrarectal	1	..	..	1
Extraperitoneal (iliac)	7	..	5	2
Total	18	3	13	3

Calculus of the upper segment of the ureter should be approached through the lumbar incision. It may then be removed by an incision in the renal pelvis or in the ureter, as its location in the ureter may determine.

(The technical operative steps are described in the chapter on the Technique of Operations on the Ureter.)

The renal condition resulting from the presence of calculus impacted in the ureter should be dealt with at the same time that the calculus is removed from the ureter. This part of the subject is more fully discussed in the chapters on hydronephrosis and pyonephrosis.

Illustrative Cases.

Case I.—(Through the courtesy of Professor John B. Wheeler, of Burlington, Vermont.) The patient was a woman, who for some months had noticed a tumor in the right side of the abdomen, which gradually increased in size until it occupied the whole of that side from the free border of the ribs to the symphysis pubis and projected prominently forward.

Operation, March 30, 1904.—The tumor was exposed by a longitudinal incision through the right linea semilunaris. It was found to be an enormous pyonephrotic kidney, which, when opened, was seen to contain about a quart of pus and the calculi (phosphatic) which are shown in the illustration (see Fig. 368). The pus was evacuated and the kidney removed. It was closely adherent to the adjacent tissues and buried in a mass of dense adhesions, and was attached to the vena cava along

the greater part of the length of the inner border. Careful dissection was required to separate it from the vessel. This was safely accomplished.

The patient made an uninterrupted recovery and was restored to good health.

CASE II.—*Bilateral renal calculus in a case in which one kidney had a double renal pelvis and a bifid ureter. Nephrolithotomy on the right kidney. Death.* (Young.[23]) Patient, a male, aged fifty-two years.

Cloudy urine for five years. Vesical irritability the only other symptom until one week prior to first being seen by the surgeon. At that

FIG. 368

Calculi from case of Prof. J. B. Wheeler.

time a sharp colic in left side of abdomen. A small calculus passed soon after its cessation. On the next day, a sharp chill, followed by fever. This soon passed off. The patient had nothing since then but the two original symptoms.

X-ray photograph of kidneys showed no calculus.

For nearly one year after this he continued to be in fairly good health. No pain or tenderness in loins at any time; no colic, no hematuria. On examination at end of this time there was no enlargement of either kidney to be made out; no tenderness on pressure over them, and no pain.

Urinary Examination: Pus, caudate and round epithelial cells.

Ureteral Catheterization.—Catheters passed without difficulty, 20 cm. into the right, and 24 cm. into the left ureter. In about one hour, 22 c.c.

and 6.6 c.c., respectively, had been collected from the right and the left ureteral catheters. That from the right showed pus and was cloudy; that from the left was clear, and showed a few red blood corpuscles only.

X-ray examination showed a large shadow in right kidney, but none in left one.

It subsequently appeared that the plate had been placed too low, so that the calculus in the upper part of the left kidney was not shown, and it was believed that none was present.

From these data it was concluded that there was a normal kidney on the left side, a renal calculus on the right, and nephrolithotomy was, consequently, advised.

Operation (by Dr. Finney).—Nephrolithotomy on right kidney. A large stone was found, the apex of which was wedged firmly into the outlet of the ureteral pelvic orifice, while its periphery branched into the calices. Calculus removed. Renal incision closed.

Following the operation, oliguria—140 c.c. only at end of first twenty-four hours. Patient died forty hours after the operation, no more urine having been secreted.

Autopsy showed the following conditions: The left kidney was very large. Its upper part, which contained a calculus and was pyonephrotic, was separated from the rest of the organ by a firm partition of connective tissue, and was furnished with a separate pelvis and ureter.

Near the bladder these two ureters from the different parts of this blended or double kidney united into one stem. The ureteral catheter had entered the channel leading to the lower part of the anomalous kidney, which part was normal, and had drawn urine from that only. Hence the mistaken inference with respect to the organ of that side.

Comment.—The point in this case which especially interests the writer is that anuria and death from the arrest of the renal function should have followed the removal of the calculus from the right kidney, for the *taking away* of that stone *should* have tended to liberate rather than to have suppressed such functional capability as may have been present in that organ, and it is stated that the lower part of the double kidney of the other side was normal, so that one would expect that there would have been sufficient actively functionating renal tissue to have carried on the necessary work of those organs. It is to be noted, however, that the renal incision is stated to have been closed after removing the calculus, and it may well have been owing to this that the failure of the kidney tissue of that organ to perform sufficient work after the operation to sustain life occurred.

The following are cases occurring in the personal experience of the author:

CASE III.—*Calculus of the right kidney shown by x-ray examination. Calculous pyonephrosis of that kidney. Nephrolithotomy. Recovery. Continuation of suppuration from the kidney. Secondary nephrectomy. Recovery. Restoration to good health. Patient last seen six months after the second operation.*

A man, aged thirty-five years. In good health until two years ago; then had an attack of pain in the right kidney. Fever, preceded by chill, accompanied this attack. The urine was clear throughout the illness, which was of a few days' duration only. After this he had no further trouble until a week before being seen by the writer. Then had an attack similar to the former one, but this time the urine contained a large amount of pus. There was no enlargement of the kidney to be made out. No tenderness of the kidney itself nor pain in it. Both were present in the epigastrium and in the middle line of the abdomen lower down.

X-ray picture showed the presence of the stone in the right kidney.

For three days before being first seen there had been very great prostration, slight cyanosis, spasm of the muscles of the right side of the abdomen, and tympanites. Temperature, 103° F. Ureters not catheterized.

Urine contained a large quantity of pus, which was thick and viscid, and sank quickly to bottom of the vessel. No renal elements. Urine ammoniacal. No evidence of vesical or prostatic disease.

Right-sided Lumbar Nephrolithotomy.—The calculus shown in Fig. 369, *a*, was readily removed through an incision in the convex outer margin of the kidney. The kidney was seen to be, in large part, destroyed by an extensive pyonephrosis.

The patient's condition was too critical to make it wise to undertake a primary nephrectomy.

Uninterrupted recovery after a few days, during which the patient's condition was grave. Delayed union of wound, but it ultimately closed. The patient gained in general health for about five weeks, then, after leaving the hospital, he began to lose weight. The urine continued to contain a great deal of pus.

Secondary Nephrectomy after an Interval of Two Months.—Recovery.—The right kidney was exposed by the so-called "paraperitoneal method," and was removed. It being found difficult to ligate the vessels of the pedicle, clamps were left on them instead. The outer wounds were closed around them. A chromicized catgut suture No. 2, that had been placed in the kidney at the first operation, was found in an almost unchanged condition, with the knot still tied.

The clamps were removed on the third day. A fecal fistula subsequently formed, which closed spontaneously four days afterward. The calculus and the condition of the kidney are shown in Fig. 369, *a*, *b*.

After this, recovery was uninterrupted. The patient was in excellent health six months later. He had gained about twenty pounds in weight.

FIG. 369

Pyonephrotic kidney and calculus removed from it. Nephrolithotomy and secondary nephrectomy.

CASE IV.—*Bilateral renal calculus with anuria of three days' and uremia of twenty-four hours' duration. Simultaneously performed bilateral nephrolithotomy. Death on the third day after operation from uremia and sepsis.*

A married woman, aged thirty-four years.

Symptoms. — Hematuria for three years; at first profuse. The bleeding was not increased by exercise. For the first month, blood in considerable quantities was present daily in the urine. After that it became less, and at the end of two months it ceased.

At that time vesical irritability continued until after the operation upon the *bladder*, which was three years before the renal condition became known. The urine contained much pus and phosphatic deposit; reaction alkaline, specific gravity, 1016 to 1020. Some blood corpuscles seen by microscope. No renal elements. Solid constituents nearly normal in amount. The bladder wall was noticeably hard and thickened on rectal examination, and bimanual palpation detected the bladder as a fairly well-defined mass.

Irrigation of the bladder brought away some gelatinous masses and a few long gangrenous shreds of tissue.

Cystoscopic examination discovered what appeared to be a perfectly

typical papilloma of the bladder, with extraordinarily long villi, which floated about in the fluid.

Operation, October 24, 1903.—*Suprapubic Cystotomy.*—The whole bladder was filled with a soft, dirty gray, gangrenous membrane, detached except at one point on the right side of the organ, where it was planted firmly in its muscular layer.

The stem by which it was attached was as large round as the middle finger, and was firm to the touch. It was divided by the writer's "scissors cautery," and removed. At the time it was believed to be a very large tumor of the bladder, which had become gangrenous. Microscopic examination showed it to be the gangrenous inner lining of the bladder itself.

The patient made an uneventful recovery. One interesting feature of the case was that throughout the time she was under observation there was no rise in temperature, nor did she at any time appear to be particularly ill.

Three years later she returned with the following story and in the following condition:

She had remained well for two years after the first operation, then began to have attacks of pain in the left renal region, which suggested renal calculus. Four months ago, pain on both sides began, and from time to time since she has had attacks of vomiting and prostration.

Four days before being seen, the quantity of the urine began to diminish, and for three days she had passed but four ounces altogether. For the last twenty-four hours uremic symptoms had been present. For the last fourteen hours vomiting had been almost constant.

Operation, January 16, 1906.—Patient placed upon the abdomen and arched over Cunningham table. Her condition was critical at the beginning and throughout the operation. The right kidney was first exposed by the usual lumbar incision. It was found to be embedded in a greatly thickened and indurated envelope, and it was necessary to tear through dense adhesions in order to reach it. A hemorrhage of recent date was seen to have taken place between the outer side of the capsula vera and the adjacent perinephritic envelope. In front the kidney was closely adherent to the overlying peritoneum. The organ was much enlarged.

While separating the adhesions a large abscess was opened. It was situated near the upper end and on the posterior aspect of the kidney, between it and the lumbar fascia. It contained a dozen fragments of a phosphatic calculus, and some individual calculi as well. The abscess communicated with the interior of the kidney. The kidney was then laid freely open and several other bits of calculi were removed. One of these

was found to be forced into the mouth of the ureter and completely blocked its passage.

There was an extensive pyonephrosis, and the kidney contained a large quantity of pus in several distended pouches separated by more or less well-defined partitions. Some of the latter were broken down in order to throw the pouches into one cavity, and the whole field of operation was thoroughly irrigated and cleansed.

While the writer's colleague, Dr. J. Bapst Blake, partly closed the wounds of this operation and arranged for drainage of the kidney, the writer exposed and laid open the second kidney in the same manner as that employed in the first operation.

FIG. 370

Calculus removed from the kidney by Mr. Shield. Weight, 1½ pounds. Circumference, 10 inches.

It was found to be smaller, less covered and bound down by adhesions, and had less secreting substance left intact than in its fellow of the other side. There was also an extensive pyonephrosis and a perinephritic abscess on this side as well as on the other. Several fragments of calculus—phosphatic—were removed. The mouth of the ureter was obstructed by calculus.

The outer and renal wounds were partly closed and free drainage from both kidneys was provided. Shock was not excessive. The operation lasted altogether twenty-four minutes.

Urine flowed freely into the dressings of the right side and somewhat less from the left kidney. She became clear in her mind for the first

twenty-four hours after the operation, then lapsed into a state of low delirium, and gradually the uremic symptoms, which had ceased during the first day and night following the operation, returned. She failed, and *died* at the end of *the third day.*

FIG. 371

Calculi of the bladder, left ureter, and both kidneys. (Warren Museum.)

CASE V (Shield[1]).—The patient was a man who, fourteen years before, had had a few attacks of moderate hematuria. There had been no symptoms of any sort between that time and a fortnight or so before his entrance to the hospital, when he came under the care of Mr. Shield. There was then some pain in the renal region and evidence of a suppurative process of one kidney.

This kidney was removed. It was found to consist of a shell of connective tissue merely. Inside this sac was a calculus weighing nearly a pound and a half, ten inches in circumference, and five and a half inches in its long diameter. The patient made a good recovery. During the preceding years the patient had led an active and laborious life (see Fig. 370).

CASE VI.—Fig. 371 is taken from a postmortem specimen from a patient who died at the Massachusetts General Hospital in 1868. The patient was a man of thirty-seven years of age, who had had urinary symptoms for twelve years past. He underwent lithotomy in 1862. At the time of entering the hospital, in 1868, he was greatly prostrated and suffering from frequent and painful urination. He died after being there a few days.

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CHAPTER XXVI.

TUMORS OF THE KIDNEY, URETER, PERIRENAL TISSUE, AND ADRENAL GLAND.

THE subject may be divided as follows: Solid tumors of the renal parenchyma, embryonic tumors, tumors of the renal pelvis and ureter, polycystic kidney, serous cysts of the kidney, perirenal tumors, adrenal tumors.

SOLID TUMORS OF THE RENAL PARENCHYMA.

The growths affecting the parenchyma of the kidney are malignant and benign. The malignant growths are hypernephroma, carcinoma, sarcoma, malignant adenoma, and adenocarcinoma. The benign growths are adenoma, angioma, lipoma, fibroma, and myxoma.

Malignant Growths.

Hypernephroma.—Etiology.—Hypernephroma may occur at all ages, but it is commonest between fifty and sixty years of age. The following table, taken from a series of 176 cases of hypernephroma, shows the age at which the tumor occurs:

Age.	Number of cases.
1 to 10 years	4
10 " 20 "	..
20 " 30 "	10
30 " 40 "	17
40 " 50 "	48
50 " 60 "	61
60 " 70 "	24
70 " 80 "	3
Not stated	9
Total	176

Males are slightly more disposed to the affection than females. In the list of cases referred to there were 102 males and 71 females; in 3 cases the sex was not stated.

Heredity has slight weight in etiology, and the same is true of trauma. The right side is a little more frequently affected than the left.

Pathology.—In 1883 Grawitz[1] for the first time gave an accurate description of a tumor occurring in the kidney, which had before that

PLATE XXXIV

HYPERNEPHROMA OF THE UPPER POLE OF THE KIDNEY. TYPICAL GROWTH.
(Watson.)

PLATE XXIV

PLATE XXXV

HYPERNEPHROMA OF THE KIDNEY. EXTERNAL APPEARANCE. (Watson.)

PLATE XXXVI

HYPERNEPHROMA OF THE KIDNEY. (Watson.)

PLATE XXXVI

HYPERNEPHROMA OF THE KIDNEY. (Watson.)

time been erroneously supposed to be an example of lipoma. Grawitz thought that the tumor originated in the aberrant adrenal tissue which is so frequently found in the kidney. He gave to the tumor the name "struma lipomatodes aberratæ renis," which has since been laid aside for the name hypernephroma.

Most of these tumors are found in the upper pole of the kidney, and they usually originate immediately beneath the capsule. The tumor may be single or multiple. The color is usually yellow, but may be grayish, reddish brown, or even black, if hemorrhage has taken place. The growth is surrounded by a capsule of its own, and is usually sharply

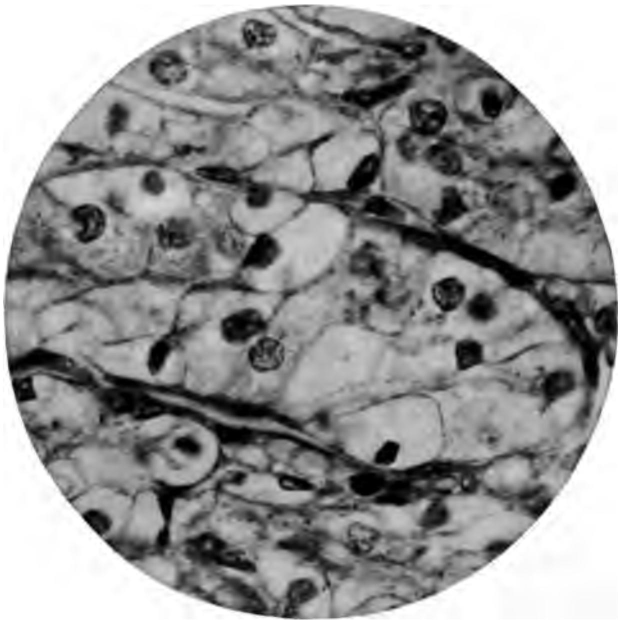
FIG. 372

Hypernephroma of the kidney, showing papillary arrangement of the cells which are intimately connected with the bloodvessels. (Pathological Laboratory at the Boston City Hospital.)

outlined. Its consistence is soft, but it may be firm and hard; softening and cyst formation follow hemorrhage in the interior. (Plates XXXIV, XXXV, and XXXVI.)

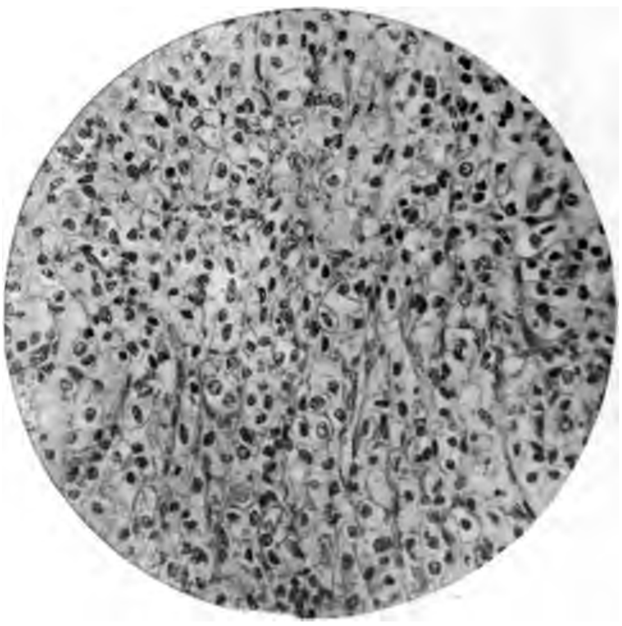
On microscopic examination the growth exhibits a structure which markedly recalls the cortex of the normal adrenal. There is a network of capillaries, which constitutes the stroma of the tumor, and upon these capillaries, arranged sometimes in pallisade form, situated close to their walls, without intervening tissue, the cells of the growth are arranged (Fig. 372). It is the stroma formed of capillaries surrounded by epithelium which is the most characteristic feature, and it is this feature which

FIG. 373



Hypernephroma of the kidney; fine detail. The polygonal cells are seen in the alveoli. (Pathological Laboratory at the Boston City Hospital.)

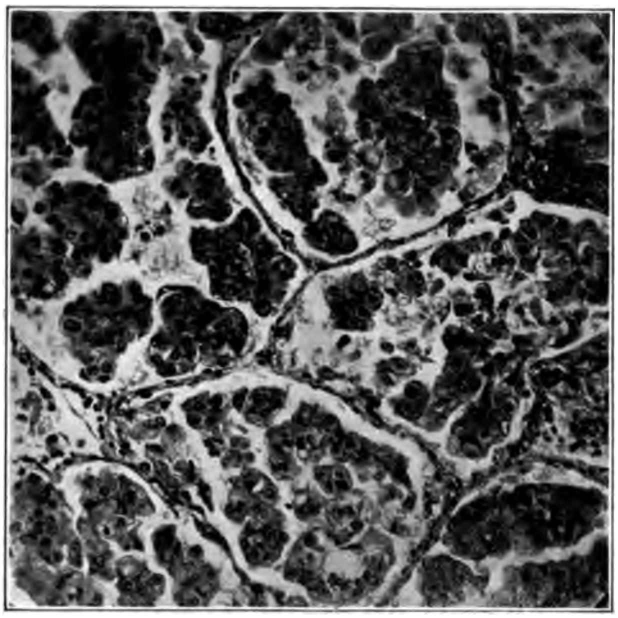
FIG. 374



Hypernephroma of the kidney, showing very well the alveolar arrangement of the polygonal cells. The stroma of the tumor is made up of fine capillaries and connective tissue. (Pathological Laboratory at the Boston City Hospital.)

has given rise to the opinion that the growth must be an endothelioma or an angiosarcoma. The cells are polygonal in outline, slightly larger than the normal adrenal cell, and they may contain infiltrated fat, which, when dissolved out, gives to the cell a vacuolated appearance. Glycogen and lecithin have been found in these growths. The cells are sometimes arranged in alveoli, which are surrounded by capillaries, upon which the cells rest (Figs. 373 and 374). This is especially a feature of the malignant form, and this alveolar arrangement has given rise to the opinion that the growth must be a carcinoma or an alveolar sarcoma. The

FIG. 375

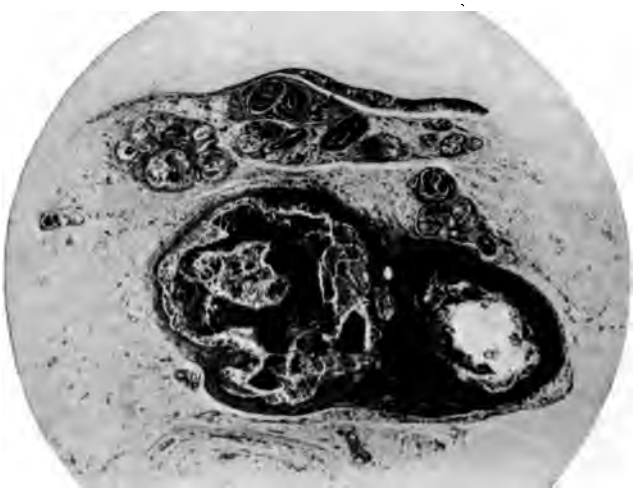


Metastasis in the lung of hypernephroma of the kidney. The alveoli of the lung are filled with branching papillary masses of tumor. (Pathological Laboratory at the Harvard Medical School, No. 3140.)

richest blood supply is always near the periphery and areas of necrosis are not infrequent in the middle of the growth. The central portion of the adrenal is sometimes, though rarely, seen typified in these growths. Ohlmacher[2] gives a case of this kind. This author noted the disposition of the reticulum, which, by anastomosis, "formed round, oval, or elongated alveolar spaces, filled with characteristic cells, recalling the reticulum of the adrenal medulla of the dog. There were also embryonic or immature medullary cells beneath the capsule of the tumor, everywhere penetrating into the deeper portion, at the same time undergoing transition, as seen in the normal developing adrenal."

Grawitz[1] gave the following reasons for believing these growths to be of adrenal origin: (1) The position of the growth under the capsule, where, as is well known, adrenal "rests" are frequently found; (2) the characteristic form of the cell resembling the adrenal cell; (3) the characteristic infiltration of the cells of the tumor, which is a feature of the adult adrenal cortical cell; (4) the presence of a capsule; (5) the relation of the cells to the stroma of the tumor, which recalls in a marked manner the appearance of the arrangement of the cells in the fascicular portion of the normal adrenal cortex, particularly with reference to the arrange-

FIG. 376



Metastasis of hypernephroma of the kidney in the thoracic duct. (Pathological Laboratory at the Harvard Medical School, No. 1342.)

ment of the cells in columns and rows; (6) the fact that metastases of kidney hypernephroma exactly resemble metastases of a similar tumor originating in the adrenal gland.

The disease is disseminated by extension and metastasis. The renal vein is frequently invaded and thrombosis results, the thrombus sometimes extending as far as the heart. Emboli are occasionally detached and find their way to the heart and lungs, disseminate the disease; or, if large, cause sudden death. The metastases exactly reproduce the parent tumor, and they are most frequent in the bones and lungs (see Fig. 375). The lymphatic system is rarely invaded. No part of the body is free from the danger of metastasis, and this danger is never absent (Fig. 376). Clairmont[2] records a case in a male, aged thirty-nine years,

who had nephrectomy performed for the disease ten years previously. After ten years of perfect health he died, and at the autopsy the disease was found in the peribronchial lymph glands.

TABLE OF METASTASES OF HYPERNEPHROMA OCCURRING IN 176 CASES OF THE DISEASE.

Axilla	2
Abdominal wall	1
Adrenal, same side	1
Adrenal, opposite side	1
Bladder wall	1
Brain	4
Bronchi	1
Clavicle	2
Diaphragm	1
Femur	7
Frontal bone	2
Gluteal region	1
General metastasis	6
Humerus	2
Heart	4
Intestines	2
Jaw	1
Lungs	21
Liver	8
Metacarpal bones	1
Not stated	28
None (?)	83
Neck	2
Occiput	2
Omentum	1
Opposite kidney	3
Pelvic bones	2
Pancreas	1
Pleura	5
Peritoneum	2
Peribronchial glands	5
Regional lymph glands	11
Ribs	6
Scapula	1
Scar	9
Skin	1
Spleen	3
Tibia	1
Temporal bone	1
Ureter, same side	2
Uterus	1
Vertebræ (dorsal)	5
Vertebræ (lumbar)	2
Vena cava	6

The discussion concerning the nature of hypernephroma of the kidney has been wide and varied. Grawitz,[4] commenting upon the minute structure of the growth, emphasized that it reminded one sometimes of an adenoma, sometimes of a sarcoma, and at other times of a carcinoma. De Paoli[5] believed in the proliferation of the endothelial cells and blood-vessels, and he classified the growth as an angiosarcoma. Beneke[6] thought the tumor a sarcoma, developing from misplaced adrenal tissue. Driessen[7] was sure that the tumor could be nothing but an endothelioma, and he drew a parallel between the kidney growth and endothelioma of bone. Sudeck[8] rejected previous conclusions and denied that the growth had anything to do with the adrenal. He insisted that the tumor was an adenoma developing from the epithelium of the urinary tubules. Lubarsch[9] agreed with Grawitz as to the suprarenal origin. He did not attempt to classify the growth, and, recognizing its obscure position, first gave to it the name "hypernephroid tumor." Manasse[10] described an "angiosarcoma," which he called a "perivascular sarcoma;" he also described a "venous endothelioma," and likewise an "endothelioma of lymph vessels." All these tumors were very similar. Kelly[11] accepted the adrenal origin and inclined to the belief that the tumor was an angiosarcoma or a perithelioma.

This great diversity of opinions shows how uncertain is the position of the growth in tumor classification.

The arguments for and against are ingenious and interesting. So far, no uniformity of opinion has been reached, and those who are in doubt about the question are in greater numbers than those who have ventured to definitely and positively classify the growth.

Those who prefer to call the tumor an endothelioma, believe in the proliferation of the endothelial cells of the bloodvessels and lymphatics. Among these are Manasse and Driessen. The latter especially is sure that the lymphatics are largely interested in the production of this growth. Manasse is likewise a strong supporter of this view, but he subdivides the tumors into three classes: the endothelioma of lymphatics, the endothelioma of veins, and the angiosarcoma.

Carcinoma is suggested by the alveolar formation, and were this the only typical appearance of the growth, there would be good reason for maintaining this exclusive view in regard to it. The epithelial-like cells of which the growth is composed are strong evidence that the growth is of a carcinomatous nature; but the mixed character of the histological structure in the same tumor militates largely against this view. Burkhardt tried to overcome the difficulty by suggesting the names "malignant adenoma," "carcinoma simplex," and "medullary carcinoma" for the growth, but this subdivision merely creates more confusion.

Those who call the growth adenoma have much to fall back upon.

The arrangement of the cells in rows and double rows with an intervening space suggests strongly, on superficial examination, adenoma formation, but the capillary network and the intimate association of tumor cells with the capillaries is decidedly against this view. Sudeck was the first to insist that adenoma was the correct interpretation, but his views have been largely discountenanced by the majority of observers. The frequent isolation of the cells, in many cases their grouping in small masses or chains, hardly recalls the typical adenoma.

Those who hold the view that the tumor is a sarcoma are quite numerous. Manasse, Ulrich, De Paoli, Busse, Beneke, Lubarsch, and Bland-Sutton are all more or less inclined to the belief that the tumor is a sarcoma. Bland-Sutton[12] is not sure that these tumors are of adrenal origin, and, without committing himself positively, inclines to the belief of a sarcomatous nature. The strongest proof of sarcoma is the disposition of the cells around vascular tufts, the angiosarcoma, which is seen in the more typical form in other parts of the body. De Paoli was sure that he could trace the bloodvessels into the alveoli themselves. The alveolar arrangement is explained by some authors as a type of alveolar sarcoma.

In discussing tumor classification we must bear in mind the histogenetic and the morphological criteria. The type of cell found in this growth is unquestionably epithelial, and this at first sight would seem to militate against the theory of a sarcomatous nature. But if we examine into the embryology of the adrenal, the latest views are to the effect that the adrenal is developed from mesenchymal cells. This was Minot's[13] and Poll's[14] view. (For the latest views concerning the embryology of the adrenal, the reader is referred to Poll's classic monograph.) Histogenetically, therefore, these adrenal cells are capable of giving rise to a connective-tissue growth, a sarcoma. If we adopt histogenetic criteria alone, then the growth is a sarcoma. Morphologically, however, it resembles an adenoma or a carcinoma. It is obvious that it is impossible to definitely decide in regard to the nature of the growth. It is evident, consequently, that until some definite agreement shall have been decided upon, in regard to tumor classification, we cannot do better than to relegate these growths to a class by themselves. The fact that they develop from adrenal "rests" in the kidney is now so commonly admitted that there are few who deny this. It seems to be an incontrovertible fact. The best name for the growth, therefore, one which suggests its pathogenesis, is that first proposed by Lubarsch—hypernephroma.

In estimating the comparative frequency of tumors affecting a given organ, clinical data are of little value. It is essential that figures to be of any value at all should be compiled from pathological records.

The following table has been compiled from the pathological records

and from the operating room specimens in both the Massachusetts General Hospital and the Boston City Hospital. In each of these hospitals there is a corps of trained pathologists who perform routine autopsies, and who during the past ten years have compiled an admirable set of records. There were performed at the Massachusetts General Hospital during the past ten years 1850 autopsies, and at the Boston City Hospital 1742, a total of 3592 autopsies. The nomenclature at the two hospitals has varied, as was natural, owing to the unsettled state in which this tumor finds itself. Tumors have been classified as hypernephromata, however, which had the usual characteristics which have been generally agreed upon as distinctive of this tumor, among which the most important are: large polyhedral cells, which are placed in close proximity to small capillary bloodvessels, an occasional papillary arrangement in places, and an alveolar arrangement in places, the alveoli containing characteristic cells. In a few instances the tumor has been classified at the two hospitals as "angiosarcoma," "perithelioma," "endothelioma," etc., but as they all corresponded to the type outlined, it seemed best to classify them all under one head. It is to be remarked, however, that at both hospitals the tumors most recently examined have all been frankly called "hypernephromata" when corresponding to the type outlined, and that the names "perithelioma," "sarcoma of adrenal origin," "endothelioma," etc., have been discarded. Most of the tumors in this table were of large size, and the great majority were very large ones.

Table of Tumors.

"Adenoma" of the adrenal (benign hypernephroma)	1
Hypernephroma of the adrenal (malignant)	3
Perirenal sarcoma	1
Papilloma of the renal pelvis	1
Hypernephroma of the kidney (large)	33
Hypernephroma of the kidney (small)	12
Carcinoma of the kidney	3
Papillary cystadenoma of the kidney (large)	4
Papillary adenoma of the kidney (small)	11
Sarcoma of the kidney (round cell)	1
Sarcoma of the kidney (spindle cell)	1
Fibroma (small)	14
Lipoma (small)	5
Myxoma (small)	1
Total	91

Symptoms.—Hypernephroma has a slower growth, as a general rule, than is usually the case in malignant disease elsewhere in the body.

With few exceptions, the symptoms are less severe than in the case with carcinoma, sarcoma, and the other forms of malignant growth affecting the kidney.

The tumor is sometimes discovered by accident, either by the patient or by the physician who chances to make a thorough examination. A small growth may remain unrecognized for many years without detection. The smallest tumors usually give rise to no symptoms at all.

Hematuria, pain, and tumor are to be looked upon as fairly distinctive of malignant disease of the kidney. If these are all present, especially if the tumor is a large one, a diagnosis of malignant disease is at once suggested, particularly in a patient of middle life.

In the beginning of the disease the general symptoms are not prominent, and there may be nothing noted except an occasional slight pain in the kidney region of the affected side. Sometimes the disease is ushered in by hematuria. Sooner or later the health and strength gradually fail, cachexia finally appears, and the patient dies from exhaustion or from some complication.

The pain is generally a dull ache in the lumbar region, and from here it may extend to the chest or may radiate to the abdomen, buttock, or thigh. Occasionally it has the characteristics of nephritic colic, and then one may suspect the passage of a blood clot through the ureter. The intensity of the pain is variable; ordinarily it is moderate; but it may be very severe, and may even cause death from the intense suffering which it occasions. It has no relation to movement or exercise and may be felt during the night as well as by day.

Hematuria is, perhaps, the most important and most characteristic symptom of the disease. Its occurrence excites immediate alarm and attracts attention to the kidneys, which had previously been supposed to be healthy. The hemorrhage comes on insidiously and without warning in most of the cases. The patient may have a sudden desire to urinate, and notices that the stream is blood red in color. Sometimes the bleeding is ushered in by a feeling of weight in the lumbar region; at other times there may be a severe renal colic at the time of the expulsion of the blood. Usually the bleeding is entirely painless. Bodily motion seems to have but little influence in starting up the bleeding, and the attacks of hematuria are quite as liable to come on in the night as during the day. This is in marked contrast to the bleeding of calculus of the kidney. Vesical symptoms are absent unless there is clotting of the blood in the bladder, in which case there may be tenesmus and frequent passage of urine. The duration of hematuria is variable Some patients do not pass blood more than a few times during the whole course of the disease; others may have an attack lasting a few months

only, and the bleeding does not return until toward the end of the trouble. As a general rule, the bleeding occurs every few weeks or months, and lasts a few hours or a few days. Toward the end of the disease the symptom is more persistent. The amount of blood is variable; usually it is not excessive, but at times there may be copious discharges, which weaken the patient. Hematuria itself is rarely the cause of death.

Hematuria is mentioned as a symptom of hypernephroma in about half of the published cases. This seems like a low proportion, and there might be some room for doubt as to the correctness of this statement were it not for the fact that in 35 per cent. of the cases it is distinctly stated that hematuria did not occur throughout the whole course of the disease.

Tumor is usually the first sign of hypernephroma. The growth generally preserves the characteristic shape of the kidney, although sometimes it is irregular and nodular. Its usual seat is in the lumbar region, and it extends forward in the process of growth. Tumor is present in a great majority of cases, and is generally discovered by the patient. The more common position in the upper pole of the kidney is an unfortunate circumstance, because this situation is unfavorable for early detection.

The relation of the tumor to the intestines is important, but this importance has been somewhat overestimated. The colon usually lies in front and to the inner side of the kidney tumor, and when distended with gas there is a tympanitic note in front of it, but the tympany may be absent if the colon is collapsed, or if it is filled with fecal matter. Artificial distention with air is sometimes of value in outlining the colon.

In examining for the tumor, the bowels should first be evacuated. The patient may be examined either in the dorsal position or on the side. The latter position has certain advantages, because the abdominal muscles are more relaxed in this position than in the dorsal.

The phonendoscope has lately come into use, and has been in some instances of service in outlining a tumor.

Photographing the tumor with the *x*-ray has sometimes shown shadows of tumor nodules on the photographic plate.

Symptoms on the part of the stomach are rare, and when they occur suggest metastasis. Dyspnœa is also an occasional symptom, and so is fever of the hectic type. Ascites and varices are due to occlusion of a large venous trunk, and jaundice when present is due to extension of the disease or to obstruction by the growth. Varicocele is sometimes a sign of kidney tumor, and is especially significant on the right side; when it occurs, it is due, probably, to compression of veins around the kidney.

The urine does not vary much in hypernephroma, and, barring the presence of blood, abnormalities are infrequent. Albuminura is occasionally present, and is, of course, abundant when there is much blood. Casts and renal cells may be found when there is associated nephritis. The presence of fragments of the growth floating in the urine are of great diagnostic importance, but they are seldom seen.

The duration of the disease is variable. In cases in which no operation has been performed the duration may be a number of years, even five or six, or more. As a rule, symptoms are endured about two and a half years before nephrectomy is submitted to. The duration from beginning to end, the nephrectomy intervening, is, on an average, three and a half years.

The early appearance of metastases always appreciably shortens the disease, especially when important organs are affected. The diagnosis of hypernephroma of the kidney has often been made, not from renal symptoms, but from examination of the bone tumor which has been removed by an operation.

Diagnosis.—In arriving at a conclusion, the subjective, rather than the objective, phenomena are more important. A patient in the prime of life, suffering from intermittent hematuria of renal origin, if he has little or no pain, and if the hematuria cannot be accounted for by the presence of other kidney disease, is probably affected with a suprarenal growth in the kidney. The two diseases most frequently mistaken are calculus and tuberculosis of the kidney.

A history of gradual decline in health is significant of malignant trouble. In the early stage of the disease, a diagnosis is well-nigh impossible. A careful examination of the various organs of the body for metastasis should not be neglected. The presence of varicocele is very suggestive, especially if it is on the right side. In cases of doubt, it is not best to wait too long before resorting to exploratory incision, especially if hematuria is a symptom. In the absence of hematuria, hypernephroma may be mistaken for almost every form of abdominal enlargement.

Treatment.—Early operation gives the best results. A small tumor inclosed in its capsule is less likely to recur than a large one, and such a tumor, which has been diagnosticated by an early hematuria, is the most favorable one for operation. It is not advisable to operate in cases in which the disease is far advanced unless there is intolerable pain, which makes a palliative operation imperative. Well-advanced cachexia is a contra-indication, and so also is the presence of metastases.

As to the choice of operation, the lumbar or the transperitoneal, opinion has materially changed within recent years. At the present time the transperitoneal is the route of choice if the tumor is a large one, because not only does it give a larger field, but also a more thorough operation can be performed. It is important that the renal vein should be ligated close to the large trunk, because it may have been invaded by the growth. Most operators prefer to ligate the vein as soon as the abdomen has been opened. All adhesions should be removed with the greatest care, because in them may be tumor tissue, which, if left, may cause further spread of the disease.

The mortality attending the operation is about 23 per cent. The immediate cause of death is operative shock, or collapse from hemorrhage. Cardiac failure has occurred in a number of instances, either a few days or a few weeks after the operation.

The prognosis depends largely on the thoroughness with which the operation has been performed. The disease is a most serious one, and it is not, as some writers have asserted, more favorable in its remote results than the various other forms of malignant disease affecting the body.

The following table, compiled from a list of 143 nephrectomies, shows at a glance the results following operation:

Immediate operative deaths	33
Died later, after operation	43
Survivals	31
Result not stated	36
Total	143

Table showing length of time that elapsed between nephrectomy and date of death:

1 year or under	22
1 to 2 years	11
2 " 3 "	6
3 " 4 "	1
4 " 5 "	1
7 " 8 "	1
10 " 11 "	1
Total	43

Death by metastasis was the rule in most of these cases. Death has occurred from metastasis as late as ten years after the operation, the patient having enjoyed perfect health in the meantime.

Table showing survival after operation:

1 year or under	9
1 to 2 years	6
2 " 3 "	7
3 " 4 "	2
4 " 5 "	3
5 " 6 "	2
6 " 7 "	1
9 " 10 "	1
Total	31

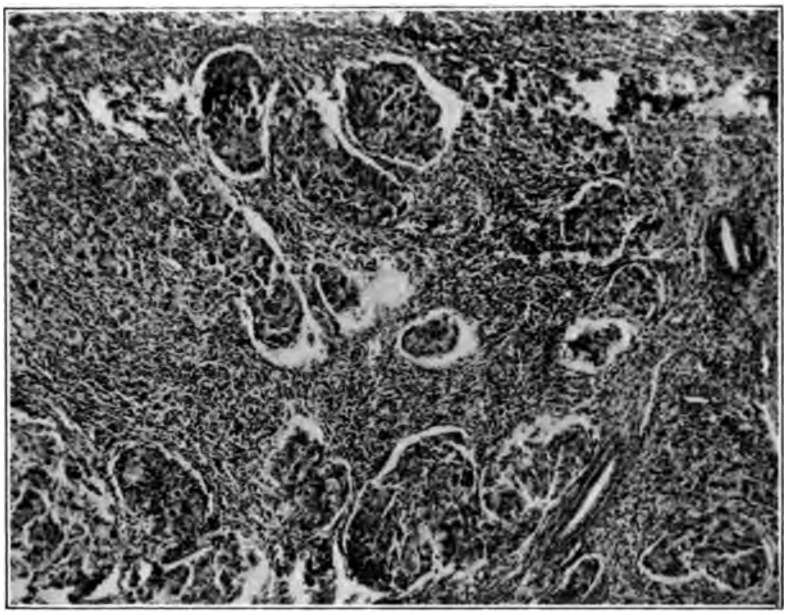
Carcinoma, Sarcoma, Malignant Adenoma, and Adenocarcinoma.—Well authenticated cases of renal carcinoma, sarcoma, malignant adenoma, and adenocarcinoma are so few that it is impossible to give many data in regard to their etiology. The disease is most common between the ages of forty and seventy years. Kelynack's[15] figures were taken from the pathological records of 4505 cases of death from all causes; among these he found 9 cases, or 0.19 per cent., of primary renal growths. Reiche[16] found among 11,930 cases of malignant disease affecting various parts of the body, 80 primary malignant growths of the kidney, a proportion of 0.7 per cent.

Pathology.—*Carcinoma.*—It is only within the past few years that these growths have been definitely separated from other forms of renal tumor. Carcinoma of the kidney has been repeatedly mistaken for hypernephroma. During the past ten years there occurred at the Massachusetts General and the Boston City Hospitals the following cases of malignant disease of the kidney:

Large hypernephromata	33
Carcinomata	3
Large sarcomata	2
Large papillary adenomata	4
Total	42

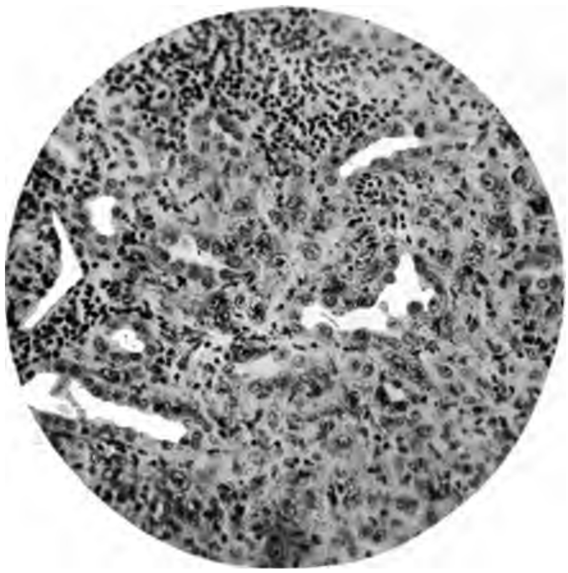
Carcinoma of the kidney results from the proliferation of the renal tubules, as was first definitely shown by Waldeyer.[17] A distinctive feature of carcinoma is the arrangement of the epithelium in alveoli, large and small, which are surrounded by a stroma of connective tissue (Fig. 377). The cells are arranged close together, one against the other, and occasionally in the centre of an alveolus there is a clear space. At times the alveoli are small and appear as little islets surrounded by abundant fibrous tissue. This is called the scirrhous form, and it should be remembered that it is of the same histological character as the medul-

FIG. 377



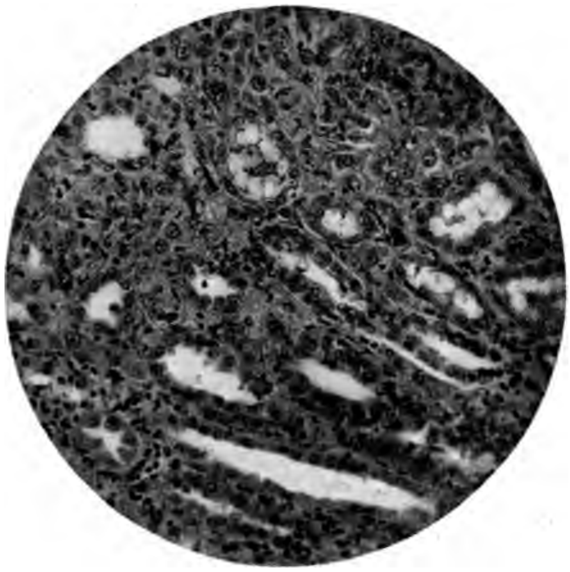
Carcinoma of the kidney parenchyma, showing arrangement of cancer cells in alveoli and masses. × 25. (Pathological Laboratory at the Boston City Hospital, No. SO 4, 768.)

FIG. 378



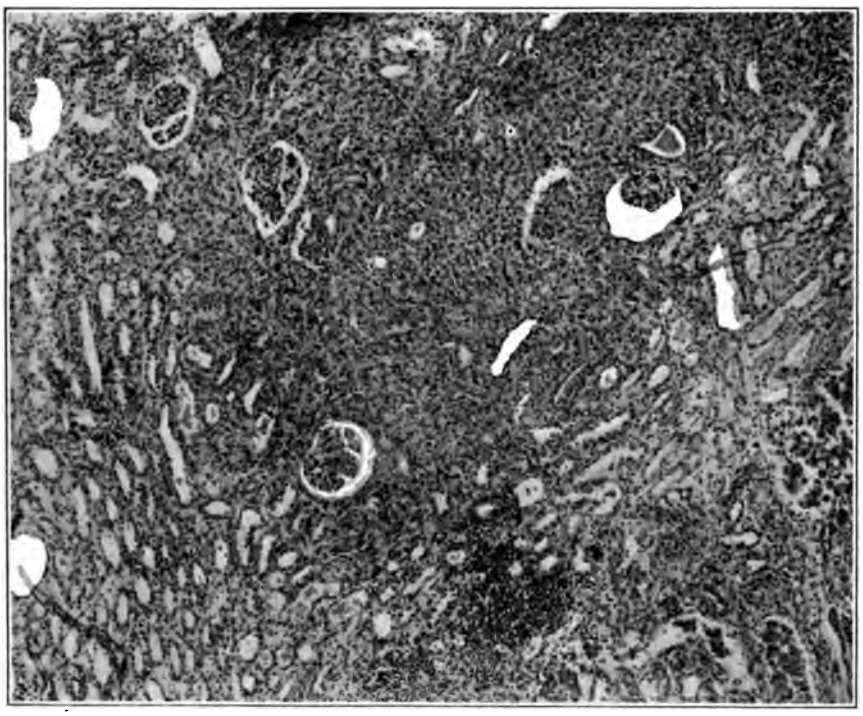
Carcinoma of the renal parenchyma, showing the arrangement of the cancer cells in columns and masses. × 190. (Pathological Laboratory at the Boston City Hospital, No. SO 5, 901.)

FIG. 379



Carcinoma of the renal parenchyma, showing the arrangement of the cancer cells in columns and masses. × 190. (Pathological Laboratory at the Boston City Hospital, No. SO 5, 901.)

FIG. 380

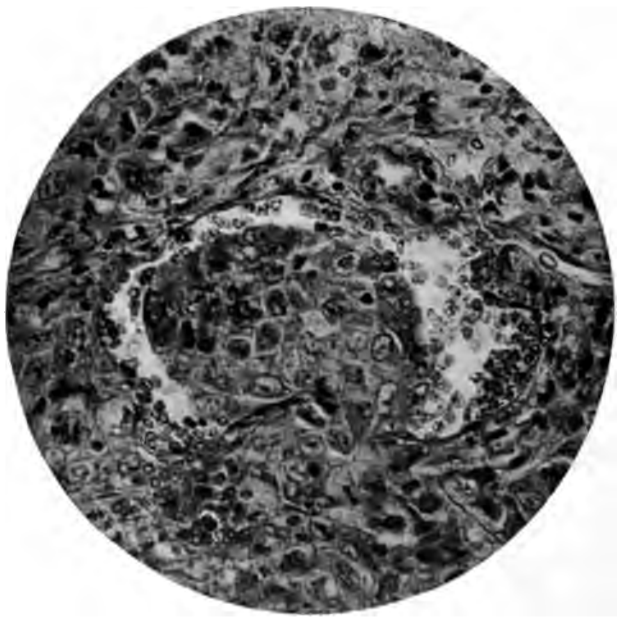


Typical carcinoma of the kidney, showing arrangement of the cancer cells in masses. × 25. (Pathological Laboratory at the Boston City Hospital, No. SO 5, 901.)

lary form, which contains less fibrous tissue and is softer. Degenerative changes are common in both.

Beside the alveolar arrangement, there is also an arrangement of the cancer cells in columns or cords of regularly arranged columnar epithelium, presenting on section a striking resemblance to the tubular arrangement of the normal kidney; in other places the cells are arranged in masses without any definite form, and they enter into the surrounding renal tissue (Figs. 378, 379, and 380).

FIG. 381



Carcinoma of the renal parenchyma, showing invasion of the intima of a bloodvessel by cancer cells. (Pathological Laboratory at the Boston City Hospital, No. SO 5, 901.)

On section, the color of the growth is either gray, yellowish, or reddish brown. (Plate XXXVII.) The capsule resists for a considerable length of time, but finally softens and breaks down and allows extension of the disease. This softening and breaking down is a distinctive feature and occurs much more frequently than in the case of hypernephroma. The growth generally involves the pelvis of the kidney and may extend into the ureter. This extension explains the persistent hematuria which is characteristic in these cases. The spread of the disease may be through the bloodvessels of the kidney (Fig. 381), especially the veins, and thrombi are formed which find their way to the heart and lungs and disseminate the disease there, or cause sudden death (Fig. 382).

Usually the disease is spread through the lymphatic system.

PLATE XXXVII

[illegible]

…, which contains less fibrous tissue and is softer. … are common in both.

… the alveolar arrangement, there is also an arrangement … cells in columns or cords of regularly arranged columnar …, presenting on section a striking resemblance to the tubular … of the normal kidney; in other places the cells are … masses without any definite form, and they enter into the … renal tissue (Figs. …).

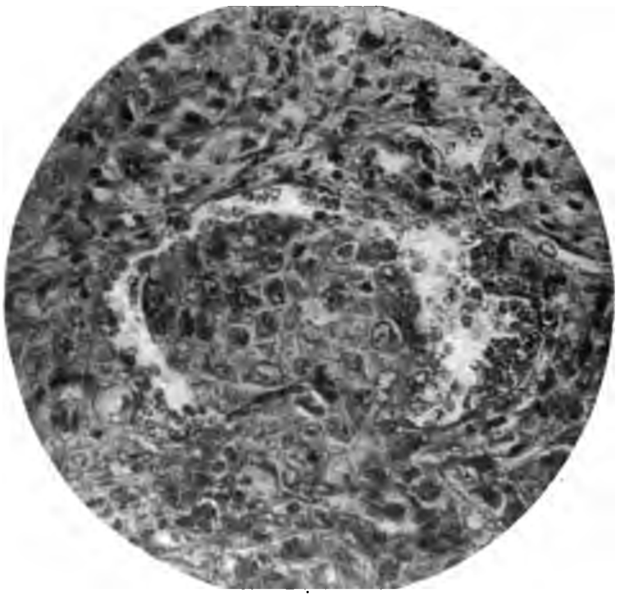
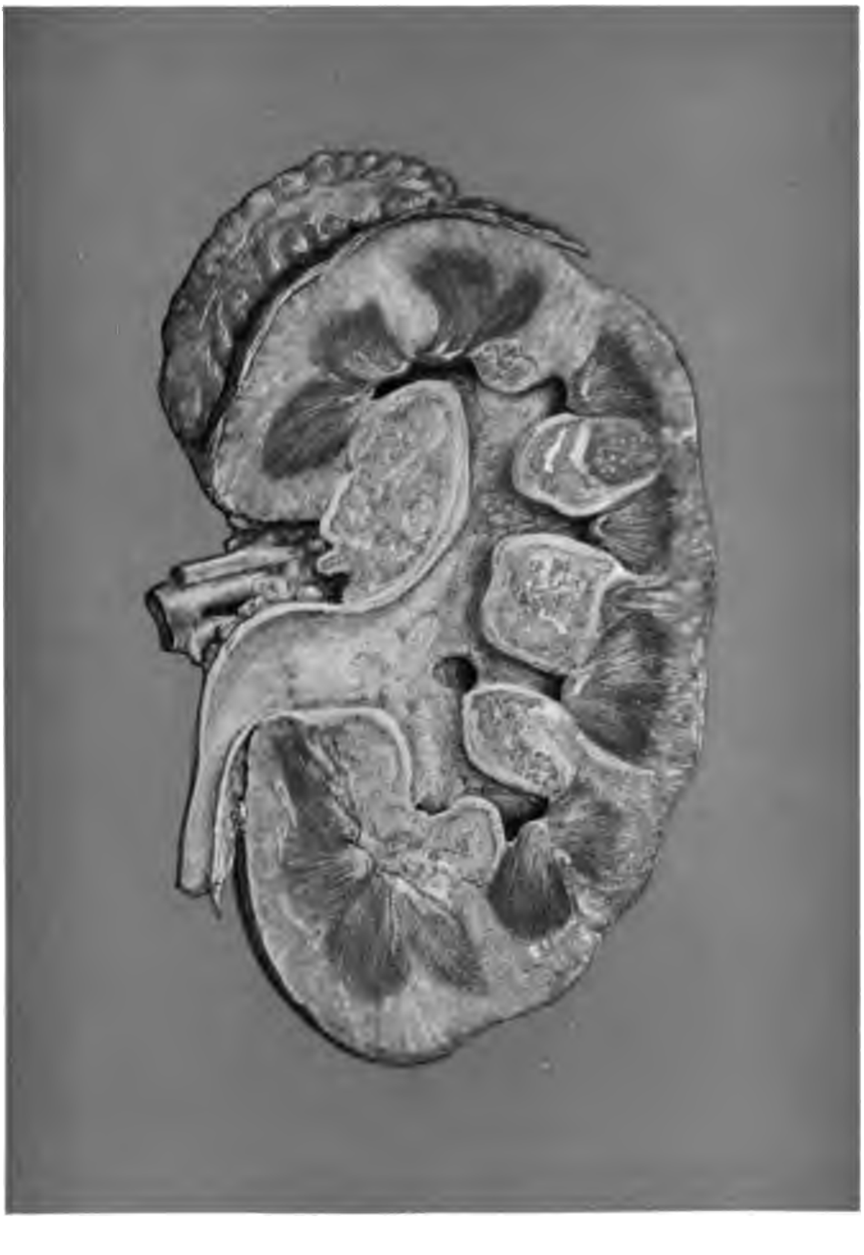


PLATE XXXVII



TYPICAL DIFFUSE INFILTRATING CARCINOMA OF RENAL PARENCHYMA.

Sarcoma.—In the adult, these tumors do not reach the size sometimes seen in children. The following forms are seen: the spindle-cell, the round cell, the fibrosarcoma, and the liposarcoma.

The tumors are soft, as a rule, and on section have the appearance of a grayish mass. They are most frequently nodular, but may be diffuse. The capsule is most frequently the seat of origin of the growth, but in some instances the tumor starts at the hilus. Either pole may be attacked.

FIG. 382

Thrombus extending into the vena cava from the renal vein in a case of pure carcinoma of the kidney. The microscopic appearance of tumor shown in Fig. 378.

The round-cell sarcoma is that in which the tumor proper consists of large numbers of small round cells, with here and there numerous lacunæ inclosing blood which in places penetrates the cellular masses. Delicate reticular tissue holds the tumor together. The growth is very vascular. The spindle-cells arranged in bundles are the characteristic feature of the spindle-cell sarcoma. The fibrosarcoma is one in which the fibrous tissue is greatly developed, producing a tumor of firm consistence. Liposarcoma is that form which, besides the usual elements of sarcoma, contains collections of fat tissue.

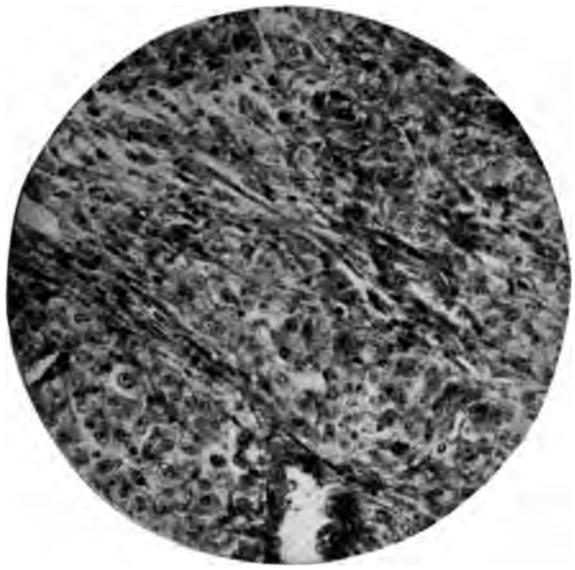
In rare instances, sarcoma of the kidney assumes an alveolar form, the alveoli being surrounded by fibrous tissue, which in some instances is quite dense (see Fig. 383).

Adenoma.—This form of tumor may be either benign or malignant. The benign form remains a local tumor and does not give rise to serious symptoms, while the malignant adenoma acts in every way like other forms of malignant tumor.

The benign adenoma is found both in the otherwise healthy kidney and in the kidney affected with chronic interstitial nephritis. The growth is usually seen at the age of forty. Its usual seat is under the capsule, but it may be found in the interior of the kidney. There is a tubular

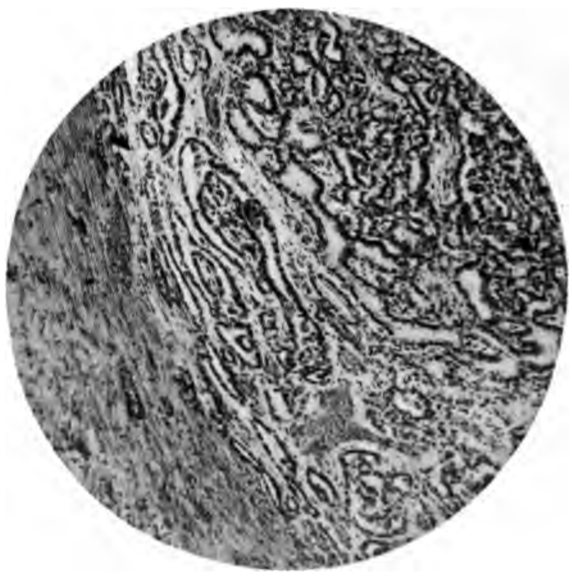
form (Figs. 384 and 385) resembling adenoma of the liver, which is characterized by the presence of cylindrical epithelium arranged in

FIG. 383



Round-cell sarcoma of the kidney, showing arrangement of the cells in alveoli (alveolar sarcoma). (Pathological Laboratory at the Boston City Hospital, No. SO 6, 251.)

FIG. 384



Tubular adenoma of the renal parenchyma, showing the arrangement of the tumor into tubules. (Pathological Laboratory at the Massachusetts General Hospital, No. 1093.)

tubular form. There is also an alveolar form, whose principal characteristic is the arrangement of cells in alveoli; and, finally, there is a papillary form which shows papillary outgrowths in microscopic cavities. The last is the form most frequently seen (see Fig. 386).

Adenoma is a disease of adult life. It may, however, occur in infancy, and this is proved by Malcolm,[18] who reports such a case in a female infant one and a half years of age. The tumor was in the right side, and was removed by operation. It measured 18 by 12 cm. The microscope disclosed closely packed tubules, the majority of which had a definite lumen. The stroma was entirely unlike that found in embryonic

FIG. 385

Tubular adenoma of the kidney, showing arrangement of the tumor into tubules. × 190. (Pathological Laboratory at the Massachusetts General Hospital, No. 1093.)

tumors, and consisted of delicate strands of connective tissue. The case was followed, and the child was still well at the age of eleven years and ten months.[19]

The malignant adenoma presents all the clinical features of carcinoma, although in histological structure it does not differ from the forms just described as benign. The papillary type usually prevails, but the alveolar is likewise common.

The relation between the benign and the malignant adenoma is obscure. The majority of pathologists believe that the two are identical, and that they differ from each other only in a clinical sense.

In the adenocarcinoma the alveolar and the papillary types again

prevail. In this tumor the arrangement is typically that of carcinoma in places. The epithelial alveoli are perfectly characteristic and leave no doubt as to the nature of the growth; an adenoma arrangement is likewise well-marked, and there are transition forms from adenoma to carcinoma, although the transition is not a sharp one.

Symptoms.—It may be stated, as a general rule, that the symptoms arising in consequence of these tumors in the kidney are very much more severe and the disease of much shorter duration than is the case

Fig. 386

Papillary cystadenoma of the kidney, showing arrangement of the papillæ. × 125. (Surgical Laboratory at the Massachusetts General Hospital, No. 78, 12.)

with hypernephroma. These tumors are of a decidedly more malignant type, and their effect upon the bodily health is earlier apparent. It is rare that a carcinoma or a sarcoma of the kidney has a duration of more than a year from the time it begins until death occurs. In the case of malignant adenoma, however, the duration may be longer. It is probable that many of the malignant adenomata are benign in the first place, and that malignancy supervenes. It is impossible to say how long the disease has existed in the benign form, because the tumor may be unrecognized for many years.

The symptoms and physical signs of these forms of malignant disease resemble those of hypernephroma. There are, however, some points of difference. The following table shows the duration of the disease in cases occurring at the Massachusetts General and Boston City Hospitals during the past ten years:

1. Carcinoma	7 weeks.
2. Carcinoma	7 months.
3. Carcinoma	7 "
4. Spindle-cell sarcoma	3 years (?)
5. Round-cell sarcoma	7 months.
6. Malignant papillary cystadenoma	3 "

The spindle-cell sarcoma had a longer duration than in the case of the others, following the general rule of these tumors.

Pain is by far the most prominent symptom. The malignancy of the growth soon shows itself by rapidly destroying the kidney parenchyma and capsule, and extends in a short time to the surrounding tissues. The nerves in the vicinity are involved, and this gives rise to the extreme pain. The suffering is excruciating, especially during the night. It incapacitates the patient early in the course of the disease, and is usually of much more intensity than the pain experienced in hypernephroma. This is a diagnostic point of some importance. Radiation is not uncommon, and the pain may extend upward into the mammary region or downward into the groin. Rapid emaciation soon occurs and the patient is reduced by suffering so that he soon has to take to his bed.

Hematuria is likewise an important symptom of this affection. The disease rapidly extends to the pelvis of the kidney, after infiltrating the parenchyma, and may even extend into the ureter. Early persistent bleeding is common, and adds not a little to the causes which produce rapid loss of strength. As in the case of hypernephroma, motion and exercise do not seem to have much influence in causing the bleeding or increasing it while it is going on. Hematuria is a distinctive symptom of these forms of malignant growth, although cases may occur in which no bleeding whatever takes place during the whole course of the disease.

The extreme malignancy of the affection does not permit of a large growth, and death may take place before the tumor has reached a large size. If thrombosis of the renal vein and the vena cava has occurred, of sufficient extent to seriously interfere with the flow of blood in the large venous trunk, ascites may result, and symptoms referable to this condition may assume prominence. In one of the cases in the table such a condition was present. The patient entered the hospital with symptoms referable to the stomach; there was also a marked degree of ascites. The patient was treated for this affection, and at his death a

large papillary cystadenoma was found in one of the kidneys. In such a case diagnosis is extremely difficult, if not impossible.

The urine is usually not much altered. The amount may be normal, and, barring the presence of blood, there may be nothing to show an altered condition of the kidney.

Diagnosis.—Carcinoma, sarcoma, malignant adenoma, and adenocarcinoma usually have a very rapid course, the disease frequently coming to an end within a very few months. The rapid course is a significant sign of the affection, and should have due weight. A previous history of failing health, especially if there has been rapid, unexplained emaciation, even in the absence of any local symptoms, should lead one to suspect some serious internal affection. When the localizing symptoms, therefore, appear, malignant disease must be the first to be considered. A person during middle age, or past this time of life, is more prone to the affection than a younger person, although it may occur quite early in life. The severity of the pain is a marked feature, and is one which should have considerable weight in diagnosis. A small tumor with severe pain and rapid emaciation is indicative of this disease. Hematuria is apt to be a marked symptom, because the growth rapidly invades the renal pelvis. Involvement of the glands about the kidney, or even the glands situated at a distance, such as the axillary and the iliac, is most significant.

Sarcoma is rather more apt to occur at a younger age than carcinoma. Hypernephroma may develop at any age, but is most common between the fifth and sixth decades. Adenomatous growths are more apt to occur earlier in life, and do not so readily give rise to metastases. It is also to be remembered that an adenomatous growth may originally be benign, may persist for a number of months, or even years, giving rise to no special symptoms, and may subsequently take on malignancy. Hematuria is a prominent symptom of carcinoma, and this disease is sure to undermine the system earlier than is the case with the other forms of growth. The more malignant type of growth, the earlier the cachexia appears. A bone metastasis is evidence of hypernephroma rather than of sarcoma or carcinoma, especially if the patient is not cachectic. Glandular involvement favors carcinoma in the presence of cachexia. In general, large tumors speak against carcinoma. Infiltrating cancer of the kidney does not cause a large tumor, but early infiltrates the surrounding tissues. Sarcoma may grow into a large tumor, which likewise infiltrates surrounding tissues. Hypernephroma, on the other hand, has in many cases a very slow growth, and may remain for several years unchanged in size. A large freely movable tumor is suggestive of hypernephroma. Carcinoma and sarcoma are more frequently attended by hematuria than is the case with hypernephroma. A long period of

time between the first and second attacks of hematuria is suggestive of hypernephroma rather than the other forms of tumor; in the latter the intervals between the attacks are usually quite short. Finally, hypernephroma is by far more frequent than the other forms of growth.

Treatment.—Operative treatment for these forms of tumor offers but little encouragement. The symptoms, however, are usually so severe that operation is in most cases imperative. Unbearable pain demands operation, and so also does exhausting hematuria. One can never be absolutely sure of the exact nature of the disease, and in spite of the discouraging outlook, an operation may be advisable.

The treatment of sarcomatous tumors by means of injections of erysipelas toxins has not resulted in any cures. This method may be useful in allaying the severity of symptoms in some cases, and its chief value is its use as a prophylactic measure immediately after operation.

The history of the cases in which a competent histological examination has been made shows that a long survival after operation is not to be hoped for. In three cases of carcinoma in which such examination was made, the survival after operation was twenty-two days, four months, and one month respectively. This opinion is in accord with that expressed by J. Bland-Sutton,[20] who states that more than one-half of the cases of carcinoma and sarcoma operated upon die from the effects of the operation, and that life is prolonged not more than a year in those who survive.

Benign Tumors.

Pathology.—The benign tumors of the kidney are not important, and they are very rare. Adenoma has been mentioned in discussing the malignant growths.

Angioma is a very vascular tumor, having the usual characteristics of this form of growth, and shows all grades of capillary dilatation. It is usually situated under the capsule, and varies in size from that of a pea to that of a walnut.

Lipoma is likewise very rare. It must be distinguished from the large deposits of fat around the kidney sometimes seen, as the result of long-standing kidney disease. True lipomata are small, rarely larger than a cherry, and they are generally situated underneath the capsule. Warthin's[21] case, however, was most remarkable. In this case the fatty tumor was the size of a child's head and had the appearance of a cystic kidney.

Fibroma is usually small. It is generally found in the cortex of the kidney, but may be found also in the medullary portion.

Myxoma is very rare.

Symptoms.—Benign growths do not, as a rule, occasion marked symptoms. They may be present in the kidney for a considerable length of time and not cause any disturbance. When they are of a large size, they cause discomfort by reason of their weight, and they then give rise to symptoms referable to pressure. It is only exceptionally that hematuria is a symptom of benign growth. Brodeur[22] records ten cases of benign growth, and in only one, a very vascular fibromyoma, weighing twenty pounds, was hematuria a symptom. Pain may be considerable if the growth is large. Œdema from pressure, varicocele, constipation, and gastric disturbances are present with large growths. Under these circumstances there may be loss of health and strength. The urine is not, as a rule, altered by these growths. The benign adenomata do not generally give rise to symptoms when they are of small size. Just where the border line is between the benign and the malignant adenoma is difficult to determine. When the tumor has begun to give rise to serious hemorrhages, when the pains appear, and cachexia shows itself, it is evident that the tumor can no longer be called benign. It may, however, reach a considerable size before these symptoms appear.

Diagnosis.—When the tumor is small, the diagnosis is very difficult; when large, it may be confounded with the many growths affecting the abdominal contents. The tumors have most frequently been mistaken for ovarian cystoma. Benign tumors are usually hard, except the lipomata, which are soft.

Treatment.—These growths should be removed, especially if pressure symptoms are prominent. The operation is not attended with a high mortality, and the prognosis is good. The lipomata may, however, recur.

EMBRYONIC TUMORS.

The tumors about to be described are decidedly different from others found in the kidney.

As their name indicates, they are supposed to take origin in embryonic tissues.

These tumors are of three main types: the dermoid, sometimes called teratoma; the rhabdomyoma, and the mixed tumors.

Dermoid.—Dermoid growths contain heterogeneous tissue elements, resembling tissues normally found elsewhere. These tissues are more or less typical of the normal tissues which they represent. The perfect teratoma, which reproduces fetal parts most faithfully, must be regarded as a fetal inclusion. These growths have been explained in various ways. The most probable explanation is, that as a result of some accident to the ovum in its early segmentation, or perhaps in conse-

quence of faulty fissions in the young embryo, certain parts grow in an abnormal position. These misplaced tissues often remain dormant for a long while, and when they begin to grow they do so very slowly.

Dermoids are exceedingly rare in the kidney, and only 2 cases have been reported. The first was Paget's[23] case of a tumor which he had seen; the second was Haeckel's[24] case of a female, aged fifty-eight years, who had a dermoid in the kidney 11 cm. in width. The contents of these dermoid tumors in the kidney do not differ from those seen elsewhere in the body; skin, hair, fat, and other tissues are found, and the cyst contains a semifluid or grumous material.

Rhabdomyoma.—The rhabdomyomata, as well as the mixed tumors, have sometimes been called teratomata, because they contain tissue which is not normally found in the kidney. The rhabdomyoma was first classified as a distinct tumor by Rokitansky,[25] who described a rhabdomyoma of the testicle. Brock[26] referred to Rokitansky's case and collected the published cases to the number of 67 occurring in various parts of the body.

The growth is of very rare occurrence in the kidney. It is difficult to determine just how frequently it does occur, because many cases of rhabdomyoma have undoubtedly been improperly classified for the reason that their histological structure has not been thoroughly studied.

These growths may be the size of a fist, or larger. The mass is at times smooth, at times nodular, and has a rounded appearance. The kidney may be included in the growth, or it may form part of it, and show as a nodule on the surface of the tumor.

Microscopically the tumor consists of striated muscle, which lies in a stroma of cells. It is by the multiplication of this muscle fiber that the tumor enlarges. All types of muscle cells are seen, each of which has a characteristic striation which distinguishes it from smooth muscle cells. They resemble voluntary muscle in shape and in staining reaction, but their color is different from the usual muscle cell. Examination, furthermore, shows that the muscle tissue never attains to full development of mature striated muscle, always stopping short of the production of perfect fibers with regularly disposed sarcous elements. In form and shape they closely resemble the muscle fiber seen in embryonic tissues. Some of the cells are of spindle form, with a more or less pronounced striation, but there are also oval, round, and regular shapes, and the cells are often multinuclear, and striated fibrillæ may surround the nucleus in concentric lines. Fibrillæ are sometimes found in the microscopic fields which look like connective-tissue fibrils, but there is this difference, that there is a cross-striation. Glycogen droplets are often found in these muscle fibers, and this has been brought forward as a proof that the

tumor is of embryonic character. The length of these fibrils is sometimes quite considerable.

The stroma of the rhabdomyoma consists of finely fibrillated interstitial tissue with a few nuclei. Sometimes the interstitial tissue is made up of young muscle cells which have not yet been striated, and they appear like connective-tissue cells. In these cases it is very difficult to distinguish the tumor from a sarcoma, and in fact many of the features of the pure rhabdomyoma are strongly suggestive of sarcoma, so that it is not easy to decide how far a combination of myoma and sarcoma may really occur. The border line between rhabdomyoma and the mixed tumors, about to be described, is therefore a very narrow one, and many authors contend that there is no such thing as a pure rhabdomyoma occurring in the kidney. Ribbert,[27] however, has classified a pure kidney rhabdomyoma, and, in what has preceded, an attempt has been made to follow along the lines that he has laid down with regard to these growths. Ribbert[28] previously tried to overcome this difficulty by describing tumors containing striated muscle with a sarcomatous stroma as "sarcoma with striated muscle fibers;" but it is probably better to put these growths in the mixed tumor class, because those tumors contain two tissues proliferating independently of each other. The writer, in a careful analysis of 100 tumors, in which a competent microscopic examination had been made, found that a combination of striated muscle with sarcoma stroma occurred in 12 per cent. of the cases. Of course, it is possible that structures common in mixed tumors might have been present and were not found, and the above percentage must be taken with this proviso.

Quite recently Wollbach[29] has called attention to the common existence of cerebral sclerosis with rhabdomyoma. Wollbach states that in a series of 12 cases of rhabdomyoma of the heart 7 had cerebral sclerosis, and he mentions the possibility of a like condition with kidney tumors. Wollbach likewise refers to Yacobaeu's[30] 25 cases of "hypertrophic tuberous cerebral sclerosis," 7 of which were associated with multiple tumors of the kidney. It should be stated, however, that in the Yacobaeu cases a histological examination of the kidney was omitted in the majority. In the published reports of cases of embryonic kidney tumors the writer has failed to find any mention of cerebral sclerosis. The subject demands further investigation.

Mixed Tumors.—The first definite attempt to separate the embryonic tumors as a class from other kinds of growth was made by Birch-Hirschfeld,[31] who recognized that these tumors presented peculiar features, which he thought were distinctive. Birch-Hirschfeld showed that the epithelial and connective-tissue elements found in mixed tumors bore a close resemblance to similar structures in the embryonic state, and it

was he who first cleared up the confusion which existed in regard to these tumors.

The following are the names which have been given to the mixed tumors of the kidney: "embryonic adenomyosarcoma," "embryonic adenoma," "myosarcoma," "sarcoma carcinomatosum," "embryonal mixed tumors," "adenosarcoma," "teratoma," "adenocarcinoma," and "teratoid mixed tumors." This long list of names shows how confusing the subject has been. These tumors present certain structures which have been called carcinomatous, but, as will be shown, the presence of sarcomatous elements, as well as the structure of the tumor, preclude the possibility of classifying these growths with the carcinomata.

Mixed tumors consist of at least two kinds of tissue, each growing independently; if several tissues are present, they grow in groups independently of each other. The rhabdomyoma in its pure form is composed of muscle fiber and connective-tissue framework; but this framework does not proliferate. A mixed tumor does not exist, even though the constituents present show two or three modifications which do not have the value of independent and unrelated tissues. These tissues do not always grow to the same extent; for instance, we may have a mixed tumor composed principally of connective-tissue structures, while glandular elements, which form part of mixed tumors, may be relatively scanty. In a mixed tumor there may be striped and smooth muscle fiber, cartilage, fat, bone, epithelial structures in the nature of tubular or glandular structures, collections of epithelium, rudimentary substance from the central nervous system, and finally, proliferating connective tissue.

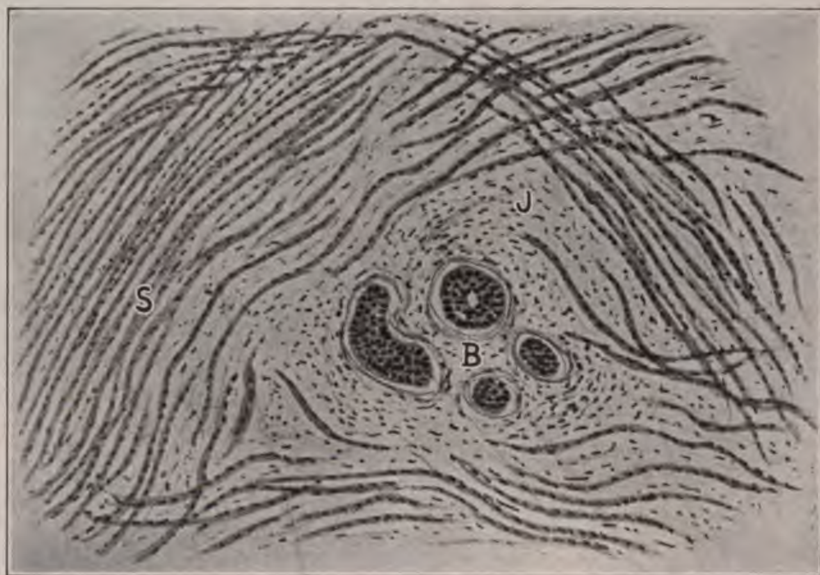
The occurrence of striated muscle is not infrequent. Walker[32] states that in only 25 per cent. of these tumors is there striated muscle, but the writer, in a series of 100 cases in which a careful microscopic examination had been made, found that striated muscle occurred in 42 per cent. Bland-Sutton[33] states that when striped muscle is present, tubular structures are, as a rule, absent. The writer cannot agree with Bland-Sutton in this statement, for in a series of 43 cases in which *striated muscle* was present, in 20 *tubular structures* were found and in 23 they were absent. The muscle fiber is not different from that found in the rhabdomyoma which has just been described. The fibers may be found everywhere in the tumors, either singly or collected in parallel bundles (see Figs. 387 and 388).

Smooth muscle fiber quite frequently occurs in these growths. It is sometimes so intimately interwoven with the connective tissue as to give the impression of a uterine myoma.

Cartilage is found in islets scattered about in the substance of the tumor, and it is said to be more frequent in adolescence than in infancy.

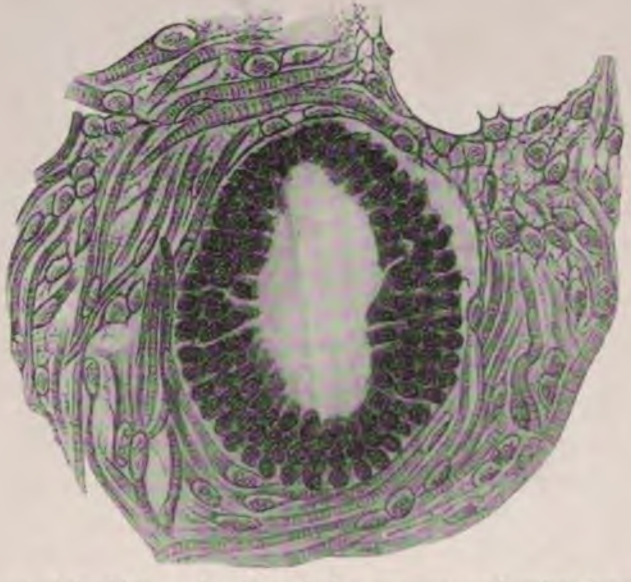
Fat tissue is likewise seen in isolated collections in the growth. Bone is seldom found.

Fig. 387



Mixed tumor of the kidney, showing striated muscle, stroma, and tubular structures. (Ribbert.)

Fig. 388



Mixed tumor of the kidney, showing tubular structure and striated muscle fiber. (Busse.)

By far the most interesting structures found in *mixed tumors* are those which are derived from epithelium. The most important of these are the *tubular* or *glandular structures* (Fig. 389). For a long time the appearances suggesting glandular growth gave rise to the opinion that the tumor must be of adenoid formation, but this view has since been entirely abandoned. They are, in fact, according to Ribbert, really epithelial structures, and should be so considered. They occur in about 40 per cent. of the reported cases. Microscopically they consist of tubules which, on cross-section, show a lumen; cubical epithelium in rows two or three deep is placed upon the walls of the tubes. The

FIG. 389

Embryonic mixed tumor of the kidney, in a child one year and ten months old, showing tubular structures. × 125. (Surgical Laboratory at the Massachusetts General Hospital, No. 64, 65.)

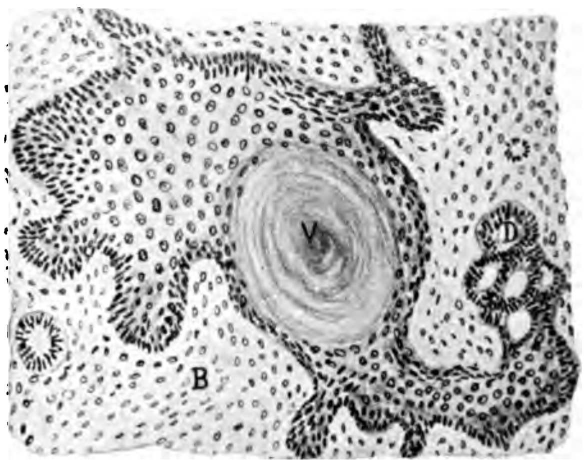
epithelium bordering on the lumen is more cubical, while that next to the wall of the tube is inclined to be more or less flattened. There is likewise a basement membrane upon which the cells rest. The form and shape of these tubules do not in any way suggest the tubules seen in the normal kidney, and they have, in fact, no connection with them. Many of the tubes are of simple elongated formation, but others may have a lateral budding, or they may be dilated into cysts of various sizes and forms. These tubules may lie in groups forming lobules, and are separated by connective tissue or muscle; occasionally they are found lying isolated in a stroma of sarcoma cells.

Another form taken by the *epithelium* are collections of *larger* or

smaller groups *and strands of cells*, which freely *anastomose*. The presence of *these epithelial "pearls"* (Fig. 390), as they are sometimes called, gave rise to the belief that the tumor must be in part a carcinoma. There is no suggestion, however, of carcinoma in these growths, because it is difficult to imagine a carcinoma in the presence of sarcomatous tissue; furthermore, it has never been shown that the epithelial "pearls" proliferate in the way that carcinoma epithelium does; and likewise in the tubular structures no one has ever seen the epithelium extend into the tissues in the vicinity. Mitoses are occasionally observed.

Ribbert[34] has likewise found a substance resembling rudimentary tissue of the central nervous system. He describes it as "a neuro-epithelial arrangement." Busse also calls attention to this exceptional finding, but those two writers are the only ones who have mentioned it.

FIG. 390

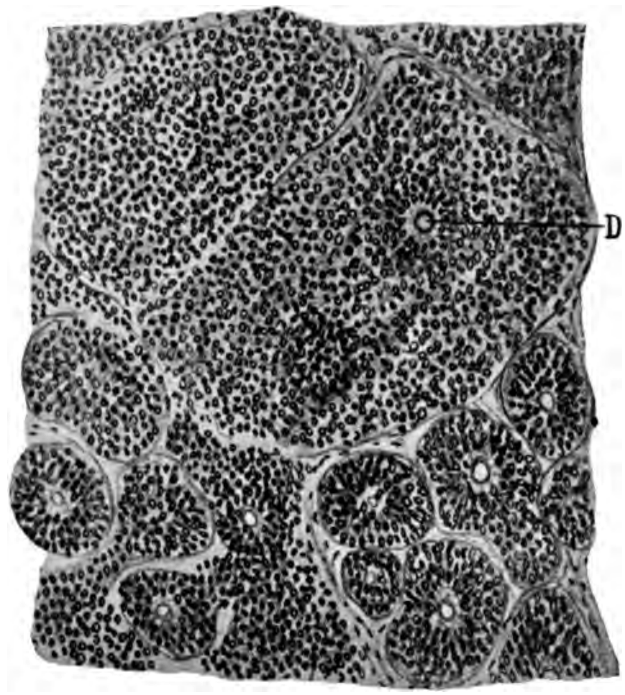


Mixed tumor of the kidney, showing epithelial structures with central cornification, and tubular structures. (Ribbert.)

The most frequent tissue found in these tumors is the *proliferating connective tissue*. It really forms the stroma (Fig. 391) of the tumor, and in it the structures just enumerated are situated. There is a delicate fibrillated connective tissue as well, running in which are the small bloodvessels which supply the growth. The sarcoma tissue is made up sometimes of round, sometimes of spindle cells, and in many instances both are present. In a series of 67 cases analyzed by the writer, spindle cells were found seventeen times, round cells twenty-six times, and in 24 cases both were present. It was the occurrence of this form of stroma which gave rise to the opinion that these tumors must be sarcomata. The cells have a decidedly embryonic appearance, and they are to be looked upon as of embryonic origin.

In many of the growths described nothing is mentioned but spindle or round cells, and the growths so described have been called examples of pure sarcoma. It is very likely that, in many instances at least, insufficient examination has failed to find other elements which would have been discovered by a more thorough examination. It is not impossible, however, that a simple form of growth, such as just described, may occur, and Ribbert,[35] speaks about these tumors. He explains them by saying that in a "theoretical sense they may be spoken of as mixed tumors," formed of only one kind of tissue. It is quite possible, however, that they

FIG. 391



Mixed tumor of the kidney. Stroma of the tumor. Tubular structures. (Ribbert.)

may be examples of pure sarcoma. Some of them seem to originate in the kidney capsule, the usual seat of origin of sarcoma in the adult. Wagner[36] mentions such a case in a child three years of age, and so also does Steele,[37] in a female child aged two years and eight months. In Wagner's case the tumor is described as a "sarcoma originating in the kidney capsule;" and in Steele's case as a "small spindle-cell sarcoma, apparently originating in the kidney capsule."

The mixed tumors of the kidney sometimes reach a very large size. When they once begin to grow the increase is very rapid, and it is not unusual to see a tumor double in size within the course of a few weeks.

Tumors the size of a child's head are not unusual, and they may be so large as to almost, if not quite, fill the abdominal cavity. Growths weighing six or seven pounds are not unusual, and they have been reported as high as ten, twelve, and fourteen pounds.

The shape of the tumor may be smooth, or irregular and nodular. Usually the growth is free from irregularities, and is felt as a smooth mass underneath the abdominal walls. The consistence of the mass may be either firm or soft; firm if the tumor is a solid one, and soft if degenerative changes have taken place within it. The older tumors are apt to be more friable than the more recent ones, and they may be easily broken.

On section, the tumor is grayish white or yellow in color, and, if hemorrhage has taken place, the darker colors may be seen. If there is much œdema within the tissues of the growth, a fluid exudes when the tumor is cut. In some instances, cyst formation occurs, and these cysts are the result of previous hemorrhage or of degenerative changes. Softening of the tumor is sometimes due to a myxomatous change, and this gives to the growth a soft jelly-like consistence. This myxomatous degeneration is due to a modification of the stroma of the tumor.

The mixed tumors almost invariably arise in the substance of the kidney. The growth takes place directly in the parenchyma, but it does not infiltrate the kidney tissue as an ordinary malignant growth usually does.

Occasionally the growth extends toward the renal pelvis, and in these cases the pelvis has become involved and the tumor masses may be seen projecting as excrescences or polypi on the pelvic wall. In rare instances even the ureter has been attacked by the growth and shows as a thickened cord. Ribbert[38] has reported a case of mixed tumor in which the ureter became occluded, with resulting hydronephrosis. A cyst was formed in consequence of the accumulated urine. On the walls of this cyst, projecting into its cavity, there were numerous papillary tumor masses. This pelvic involvement is not at all usual, and but few cases have been reported.

Rhabdomyoma and the mixed tumors present certain features which are common to both. They are as follows: Both the tumors grow in an expansive way. There is no real infiltration of the surrounding kidney structure, as already stated, but rather the kidney tissue is pushed aside by the growing mass, and the kidney is, in consequence, either flattened or spread out; in some cases it appears as a sort of excrescence on the top of the tumor itself. The compressed renal tissue suffers changes in the nature of atrophy. The glomeruli and tubules are compressed

and appear much smaller than they are in the normal condition. That part of the kidney which is not subject to the pressure functionates in the normal way, and urine is secreted. Obstruction of the ureter is of exceptional occurrence, probably because hemorrhage is relatively infrequent; this is in sharp contrast to the rather frequent hemorrhages which are seen in other forms of growth in adults.

Surrounding the tumor there is a sort of capsule, which is not a real one, but is rather of a spurious nature, and is formed partly by the kidney capsule and partly by the renal tissue itself. Inflammatory changes in consequence of pressure likewise lead to the formation of a connective tissue, and this further serves to increase the size of the capsule.

Invasion of the renal vein by the growth has been mentioned in a number of instances, and thrombi are formed, which may extend into the vena cava. Loosened emboli may find their way to the heart and lungs, and may cause sudden death or lead to the extension of the disease by metastasis. Extension into the veins, however, is not nearly so frequent as it is in the case of kidney tumors in the adult.

The tumor as it grows displaces neighboring organs, such as the stomach, spleen, and liver, and large tumors may press the diaphragm upward even as high as the fourth rib.

Metastases of these growths are relatively infrequent. The tumor is essentially a local growth, and is not apt to extend to surrounding tissues. Exceptionally, however, this does occur, and the growth may attack, for instance, the bowel or some other contiguous organ.

The lymphatic system is almost never invaded, and Birch-Hirschfeld[30] asserts that no rhabdomyoma has yet been found with metastases in the lymphatic glands. In the case of the mixed tumors, however, the glands are sometimes, though very infrequently, invaded.

Walker,[32] in an analysis of 142 cases of mixed tumors, found 55 cases in which there were metastases:

Liver and lungs	11
Opposite kidney	11
Retroperitoneal glands	10
Mesenteric glands	6
Vena cava	6
Pleura	3
Liver	4
Portal vein	1
Diaphragm	1
Scrotum	1
Bladder	1

Walker also states that in a few instances the colon, adrenals, and small intestines were invaded by continuity.

The writer found metastases to occur in about 21 per cent. of the cases. The organs attacked were the following:

Liver	7
Lungs	9
Peritoneum	5
Dura mater	1
Scrotum	1
Iliac fossa	1
Vena cava	2
Axillary glands	1
Bowel	2
Retroperitoneal glands	2
Mediastinal glands	1
Mesentery	1

Floriken's[40] case, in which there were metastases in the dura mater, is quite unique. It was a case of a boy, five years old, who had a large tumor in the left kidney the size of a child's head. There were metastases in the dura mater in that part bordering on the frontal and parietal regions. The structure of this tumor was that of a spindle-cell sarcoma, and there were likewise scattered about in its stroma many tubular structures which were lined with cylindrical cells.

The smaller growths are not apt to give rise to metastases at all, and usually it is only when the growth is of large size and has broken through the capsule that metastasis may take place.

Pathogenesis.—The pathogenesis of rhabdomyoma and the mixed tumors is undoubtedly the same, for the features of both are very similar.

The first attempt to explain the origin of these growths was made by Eberth.[41] Eberth was struck with the peculiar embryonic look of the tissues, and he tried to explain the muscular elements by supposing that in some way in embryonic life portions of the Wolffian body became included in the kidney, and subsequently developed in it.

After Eberth, Cohnheim[42] thought that the striated muscle in the rhabdomyoma might originate from the primitive vertebræ, from which a considerable part of the musculature of the body is derived, and he thought that some of the muscle cells might become mixed with the first anlage of the kidney and develop in the permanent kidney. He called attention to the fact that the first anlage of the urogenital tract lies in the direct vicinity of the primitive vertebræ.

Birch-Hirschfeld[43] called attention to Eberth's theory of the origin of the growths, and he was inclined to agree with this pathogenesis. In a subsequent article Birch-Hirschfeld[44] definitely, for the first time, collected these tumors in a single class, and he showed that they must, from the great similarity which marked them, all belong to one special class, with a

single pathogenesis. He called attention to the typical groundwork of the tumors and to the mixture of glandular and archiblastic constituents which, in form and arrangement, recalled embryonic tissue inactive proliferation. Birch-Hirschfeld[45] first gave to the growths the name "embryonic adeno-sarcoma." He called attention to the great difference between these tumors and true carcinoma, which has origin in epithelial cells, and it was evident to him that they could not be carcinomata on account of their sarcomatous constituents. The behavior of the tumor was unlike that of carcinoma, and there was also an absence of glandular involvement which characterizes the typical carcinoma. As to pathogenesis, Birch-Hirschfeld[46] agreed in the main with Eberth, who derived these tumors from inclusions of the Wolffian body. The origin of the tumor from the remains of the Wolffian body would explain, he thought, both the close relationship of the tumor to the kidney and the renal pelvis, and also the absence of a true intermingling of the tumor tissue and the renal tissue in the sense of a transition between the elements of the two.

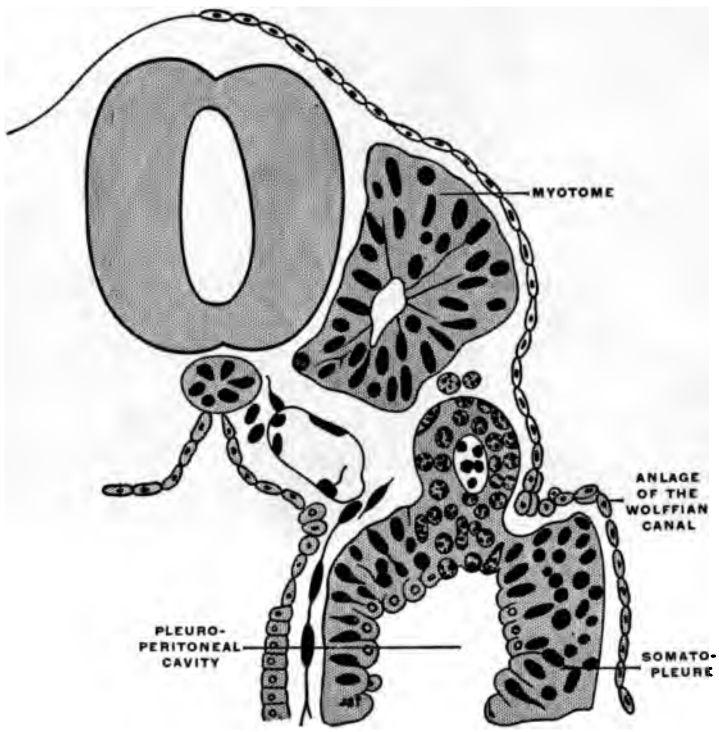
Willms,[47] in his well-known monograph on mixed tumors, went a step farther. He derived these tumors from primitive islets of embryonic tissue in the first stage of development. He derived the *striated muscle from the myotome* (Fig. 392); *connective tissue, fat, and cellular tissue from the mesenchyma, and the tubular structures from the Wolffian body.*

Muus[48] believed that the origin of these tumors could be sought in the kidney itself, and he based this opinion on the fact that, in the embryonic kidney, structures were found very similar to those found in the tumor. Muus thought that at an early period in fœtal life an isolated portion of the kidney anlage took on a pathological growth instead of a normal. The embryonic type was thereafter maintained unchanged, and he thought the different elements proliferated excessively and irregularly. The other parts of the kidney anlage developed normally. He thought that fat and cartilage were formed by metaplasia of the connective tissue; that myxomatous tissue was merely a modification of the connective tissue; the striped muscle he believed to be derived from proliferation of the mesodermal cells in the earliest period of the kidney anlage, at which time not only the different connective-tissue modifications, but also muscle, might be formed by excessive proliferation. The epithelial formations he believed not to be derived from the primitive kidney, but from the kidney anlage itself.

Herzog[49] explained these tumors in the following way: "To give our views as to the pathogenesis of these tumors, it is necessary to enter very briefly into a discussion of the development of the myotomes and of the Wolffian body. These structures are developed from the early meso-derm, which is first differentiated into the myotome and the lateral plate. Between these structures there is formed a thin bridge known as the

nephrotome; in the latter the transverse excretory tubules of the Wolffian body, emptying later on into the Wolffian duct, are formed. While the tubules develop the nephrotome becomes entirely cut off from the myotomes. This is, in short, the normal course of events. With reference to the embryonal renal adenosarcomata, we assume that they owe their origin to an inclusion which is formed in the following manner: The nephrotome is not cut off at the normal site, but in such a manner that a part of the myotome is severed from the main mass and remains in connection with the nephrotome. The separation may take place so

FIG. 392



Transverse section of human embryo. (Kollmann.)

that only a part of the myotome proper is cut off, or a part of the sclerotome may likewise be taken along. If the former is the case, we have the matrix for striated muscle fiber only; if the latter occurs, we have also the matrix for cartilage. If, now, we assume that a part of the nephrotome (Wolffian body) to which tissues of the myotome proper or the latter and the sclerotome have become adherent by an abnormal process of embryonic separation becomes included in the permanent kidney, we have a matrix containing all those embryonic elements which occur in the mixed tumors of the kidney, namely, striated muscle fibers, cartilage, other connective-tissue elements, and epithelial glandular

structures. The latter, of course, are derived from the excretory tubules of the nephrotome."

Jenckel[50] agreed in the main with Muus in deriving these tumors from the embryonic kidney. The origin of the smooth muscle fiber, according to Jenckel, was not difficult to explain, because it is seen everywhere in the embryonic kidney. He thought also that fat, cartilage, and even epithelial formation might have an origin in the embryonic kidney, in view of the origin of the kidney from cells of the middle germinal layer. Jenckel was somewhat in doubt about the origin of the striated muscle, and could not be sure whether the striped muscle should be explained by the hypothesis of metaplasia from smooth muscle or whether Willms' view was correct.

Ribbert[51] believed that mixed tumors could arise only from cells which are isolated and still undifferentiated; that is to say, morphologically indifferent. Ribbert called attention to the fact that tumors of this class arise especially in the urogenital tract, namely, in the kidney, uterus, bladder, and vagina; this would seem to point to a common origin. Ribbert[52] asked whether it was not possible that all mixed tumors of the urogenital tract may not arise from *germinal cells* which have been isolated early in embryonic life. "It is only a short step from the anlage of the sexual glands to the neighboring kidney, and these might easily be taken up into the Müllerian or Wolffian duct. Whether the displacement of the germinal cells is active or passive may be disputed. I would assume that it is active. These cells, which have lost their organic connections, find their way into the kidney region and move downward in both ducts. They may wander through the Müllerian ducts and remain on their inner surface; or, what is more probable, through the Wolffian duct and develop in the wall of the cervix of the vagina. We thus have a simple explanation for all of the mixed tumors of the urogenital tract, and bring them into connection with the teratomata of the ovary and testicle."

Busse[53] rejected the theory of misplaced tissues and derived the tumors from the embryonic kidney. He derived the striated muscle from metaplasia of the smooth muscle, basing his opinion on the following grounds: (1) "Large numbers of transition forms; (2) position and arrangement of striped fibrillæ, which is not that of the somatic musculature, but that of unstriped muscle; (3) the occasional presence of striation in places where only smooth muscle is found; (4) the discovery in the pregnant uterus of striated fibers, this being explained upon the basis of a metaplasia of the highly developed involuntary muscle of the uterus in pregnancy." As for the other structures found in these tumors, he derived them from the embryonic kidney, and he called attention to the similarity of the tumor structures to structures in the embryonic kidney. In a

later article, Busse[54] reiterated his belief in regard to the origin of these tumors.

Carey[55] derived the tumors from metaplasia of the tissues of the embryonic kidney. Thus sarcoma-like tissue is derived from round cells; epithelial tissue, from the interstitial tissue; mucoid tissue, cartilage, and fat, from the connective tissue; smooth muscle fiber, from that normally found in the kidney; and striated muscle fiber, from metaplasia of the smooth fiber.

Bland-Sutton[33] rejected an extrarenal origin for these growths, and stated that a study of the fetal kidney demonstrated very clearly that these growths arise in the connective tissue of the renal sinus. "The tubular structures are due to entanglement of the uriniferous tubules in consequence of the sarcoma invading the cortex, while the striated muscle is derived from the muscle tissue of the renal pelvis, which is an expansion of the hollow muscle known as the ureter."

It is evident, from a perusal of these various views in regard to the pathogenesis of these tumors, that there is no uniformity of opinion. It will be seen that there are three theories which have been evolved. The first is the theory that the tumors are derived from the Wolffian body; the second, that they are derived from the embryonic kidney; the third, that they are derived from aberrant cells of the myotome, or other similar structures.

The theory that the tumor is derived from the Wolffian body has been largely discountenanced. There is nothing to show that the Wolffian body furnishes abnormal aberrant tissues, for these aberrant islets have never been found in the kidney or elsewhere, although the structure is easily recognized. Furthermore, the Wolffian body cannot give rise to striated muscle fiber.

The fact that these tumors are so frequently found either at the time of birth or shortly after birth, or even in fœtal life, shows that their origin must be intimately associated with early tissue changes. It is probable that tumors growing in childhood and first recognized at the age of three or four years may have been latent in the kidney for a considerable length of time. The tumors growing in adults, although they are of extreme rarity, are more difficult to explain. Their precisely similar microscopic structure would seem to demand a similar origin, but it is difficult to imagine a latency which has extended over a period of many years. Yet that such a latency does exist is proved by the case of Jenckel,[56] that of a female, aged thirty-four years, who carried a tumor in the right kidney for a period of eight years without special inconvenience. It was removed, and the patient was well two years later. The microscopic examination of the tumor showed smooth muscle, cartilage, and tubular structures, and the growth had a distinct stroma of spindle and round cells. The long period of time during which the tumor was carried

shows that the growth was not a rapidly growing one, and argues for a latency which might easily have extended over a long period of time before the growth was noticed.

Those who try to explain the growth on the supposition that it has originated from tissues in the embryonic kidney have difficulty in explaining the presence of striated muscle. Ribbert[57] utterly rejected the theory that striated muscle is a result of metaplasia of smooth muscle fiber. The latter is a normal constituent of the kidney. Ribbert denied that there is any genetic relation between the two forms of fiber, and he believed that they are not connected in any way with each other, and that, therefore, any transition between the two must be excluded. Bland-Sutton and Busse were both strong supporters of the view that the tumor originated in structures already in the kidney. Jenckel was likewise strong in this view, and he thought that he could prove that the origin of the tubular structures was from the embryonic kidney. He referred[58] to a case of a male epileptic, aged fifty years, who had what Jenckel considered to be "a representative of an embryonic kidney, which remained stationary at a certain stage of development." This rudimentary kidney corresponded to the first or second month of embryonic development and was composed of "a mass of cellular connective tissue interwoven with smooth muscle, elastic fibers, and numerous tubular structures very similar to those seen in a large mixed tumor. There were no glomeruli, and there was no transition between the glandular formations and the renal pelvis." The strongest supporter of the view that the tumor is derived from kidney elements already present was Bland-Sutton, but he merely states his opinion without giving any arguments for or against.

The theory that the growth is due to inclusions of the myotome and similar structures is the one which has been most supported. Willms was the originator of the theory, but the difficulty in accepting Willms' view comes from the fact that it presupposes too many possibilities. He derives the tissues from the myotome, from the mesenchyma, and from the Wolffian body. Herzog was likewise a strong supporter of the view that the nephrotome had much to do with the origin of the tumor. Ribbert's view appears to be plausible, and it certainly would seem to explain all the mixed tumors of the urogenital tract. The pathogenesis of these tumors is obscure. No one theory is satisfactory.

Etiology.—Embryonic tumors of the kidney are especially common in infancy and childhood. Albarran and Imbert[59] found 416 cases of tumor in the adult and 173 embryonic tumors in childhood.

Walker,[60] in a list of 130 cases in which the sex was mentioned, found 55 in males, 51 in females, and in 24 the sex was not stated. Albarran and Imbert[61] found 80 in males and 55 in females. In the writer's

tables there were 50 males, 45 females, and in 5 the sex was not stated. The age at which these tumors appear may be seen by a glance at the following tables. Albarran's and Imbert's[62] is as follows:

	Cases.
From 0 to 3 years	89
" 4 " 6 "	42
" 7 " 9 "	21
" 10 " 12 "	7
" 13 " 15 "	6

Steffen's[63] list is as follows:

	Cases.	Male.	Female.	Sex not stated.
Stillborn	2	..	..	..
Under 1 year	34	9	10	15
1 year	15	5	7	3
1½ years	17	4	8	5
2 "	23	7	9	7
2½ "	11	6	4	1
3 "	31	11	16	4
4 "	22	9	10	3
5 "	15	5	10	..
6 "	15	6	9	..
7 "	7	3	3	1
8 "	7	2	4	1
9 "	4	4	..	..
10 "	2	1	..	1
11 "	4	1	3	..
13 "	2	1	1	..
15 "	1	..	1	..
16 "	1	..	1	..

The writer's table is as follows:

0 to 1 year	10
1 " 2 years	21
2 " 3 "	16
3 " 4 "	13
4 " 5 "	11
5 " 6 "	12
6 " 7 "	3
7 " 8 "	3
8 " 9 "	2
10 " 11 "	1
11 " 12 "	1
13 " 14 "	1
18 " 19 "	1
30 " 40 "	2
40 " 50 "	1
50 " 60 "	1
Not stated	1
Total	100

The adult cases referred to in the above table were: Busse's,[64] in a female, aged fifty-seven years; Hoisholt's,[65] in a male, aged eighteen years; Jenckel's,[56] in a female, aged forty-three years; Kocher and Langhans',[66] in a female, aged thirty-five years; and Muus[67] and Marchand's,[68] in a female, aged thirty-four years.

These adult cases show conclusively that the disease is not confined to the period of childhood and infancy, as some writers would have us believe.

In 100 cases analyzed by the writer the tumor affected the left side in 41 instances, the right in 37, both sides were affected in 6, and in 16 there was no mention made as to the side affected.

In Albarran and Imbert's[69] list of 138 tumors, both sides were affected four times; the left, sixty-nine times, and the right, sixty-five times.

In Walker's[70] 141 cases the left side was affected seventy-three times, the right, fifty-eight times, and the disease was bilateral in ten instances.

The bilateral cases are interesting, and of course the question arises as to whether the disease did not start in one kidney and later attack the second one by metastasis. Judging from the rarity of metastases in this disease, it seems more likely that both kidneys are attacked independently, but there is no proof that this is so.

Trauma has been mentioned by Walker[71] as an exciting cause of the growth thirty times in 142 cases. It is likely, in view of the probable pathogenesis of the disease, that trauma by itself has nothing to do with the causation of the growth, but a blow may well start up to active growth a tumor which has previously been latent. Heredity may predispose to the disease, and Albarran and Imbert[72] mention that it was noted five times in 173 of their cases. In the writer's list of 100 cases it was mentioned once as a possible predisposing cause of the disease.

Symptoms.—In a great majority of the cases subjective symptoms are entirely absent in the first part of the disease. The patient may have apparently perfect health, and yet there may be an abdominal tumor which is rapidly growing. Frequently the growth is not discovered nor appreciated at all until it has become well started, and instances have been reported in which a comparatively large tumor escaped observation until just a few days or a few weeks before nephrectomy was performed. Occasionally, symptoms of emaciation and gradual decline lead to a thorough physical examination of the child, and a tumor is found in one or the other hypochondriac regions. Pain is but rarely the first symptom of the disease, and the same is true of hematuria. Occasionally the disease is ushered in by a gastro-intestinal attack, with vomiting and diarrhœa. The disease has been ushered in by convulsions, with temporary anuria, which was followed by an attack of hematuria. An unusual onset is by dyspnœa, severe coughing, and sleeplessness.

By far the most prominent feature of the disease is tumor. As an initial symptom it was found by Albarran and Imbert[73] in 71 per cent. of the cases. In the beginning of the disease the tumor appears under the ribs in the region of the kidney, and it may be smooth or nodular in outline. It is easily palpated, and, as a rule, is not sensitive to pressure unless there is some inflammatory reaction in its vicinity. It is not unusual for the growth to enlarge with great rapidity, especially after it has reached an appreciable size. It may rapidly extend to the median line of the body and may even fill the entire abdominal cavity. The growth is not influenced by respiratory movements. Walker,[74] in 27 out of 142 cases, found that the colon passed over the tumor and was adherent to it. Walker notes that the colon probably had this position in a much larger number of cases. Semifluctuation has been obtained in a number of instances, even in those growths which contained no cysts. This feeling is probably due to the occasional soft character of the growth. On percussion, a dull note is obtained, except over the part which is occupied by the intestine.

Pressure symptoms are very common, and they are due to the large size of the tumor, which encroaches upon the neighboring organs. Œdema of the legs has been remarked in a number of cases, and accumulations of fluid in the abdomen are not very infrequent. The explanation of these phenomena, of course, is to be sought in the pressure of the tumor upon the bloodvessels in the vicinity. It is not unusual to observe enlargement of the veins coursing over the abdominal wall, and this collateral circulation is to be explained by the pressure of the growth on the large bloodvessels within the abdomen, which impedes the passage of blood through them. In some instances separation of the recti may occur as the result of a large-sized tumor. Dyspnœa, cyanosis, and œdema of the lungs are likewise symptoms of considerable importance. A tumor on the left side of the body pressing upward may displace the diaphragm, and, with it, the heart. A tumor on the right side may compress the bile duct and give rise to intense jaundice. Neuralgia of great severity, affecting the intercostal nerves and branches of the lumbar plexus, may also occur. Occasionally a tumor of large size in a very young patient may cause deviation of the spinal column.

Pain is not a prominent symptom in this form of tumor. Imbert[75] found pain the initial symptom in 20 per cent. of the cases. The writer found it the initial symptom in 7 per cent. of the cases, and it was present during some stage of the disease in 20 per cent.; in 9 per cent. it was distinctly mentioned that pain was not present at any time during the course of the disease. The pain is dull and heavy and is apt to be continuous; when it is due to blocking of the ureter by a blood clot it takes the character of severe colic and occasions much suffering.

Imbert[75] found hematuria as the initial symptom in 5 per cent. of the cases, figures which correspond almost exactly with those of the writer, who found the symptom mentioned as the first one in the disease in 6 per cent. of the cases. Albarran and Imbert[76] found the symptom present at some time during the disease in 16 per cent. of the cases. Hematuria, therefore, is not a prominent symptom of embryonic tumors, and this is in contrast with the much greater frequency in other forms of tumors occurring in the adult. When it does occur the amount of blood lost is not usually abundant. A single attack of hematuria may mark the onset of the disease, and there may be no more bleeding afterward. Occasionally the attacks come on at intervals of a few weeks and soon subside; the patient may not have more than two or three attacks during the whole course of the disease.

The urine is not usually altered, and that secreted is, as a rule, normal in amount and in solid constituents. Occasionally it is diminished to an appreciable extent, but this seldom happens. Anuria almost never occurs. It has been supposed that anuria is caused by compression of the ureter on the opposite kidney; another explanation is that the phenomenon is reflex in character. In rare cases albuminuria has been noted.

Symptoms on the part of the bladder are very rare. Frequent micturition, reflex in character, or due to blood clots in the bladder, may occur. Incontinence has been reported a few times, and also retention of urine. In these cases the explanation is probably to be sought in some disturbance of the nervous system.

The general symptoms of the disease are those usually seen in malignant affections. When the tumor has gotten well under way, emaciation may be quite rapid, and loss of strength, anorexia, and general weakness are apparent. The gastro-intestinal tract is very apt to suffer, and vomiting and diarrhœa are occasionally present. Fever of a hectic type has been reported in a number of instances, and this serves to hasten the end. Sleep is very apt to be disturbed, and this sleeplessness has occasionally been remarked in the first part of the disease. Reflex symptoms may be noted, such as headaches, cough, dyspnœa, orthopnœa, and a peculiar choreiform twitching of the muscles. Osler[77] reports a case in which death was caused by a convulsive fit of choking.

These tumors are exceedingly malignant, and frequently end life within a very short period of time. The minute histological structure of the tumor appears to have no special influence in regard to malignancy, and the writer found that when the stroma was composed of spindle or round cells the disease ended equally rapidly. These tumors are among the most malignant of any type of tumor. The following table shows

the duration of the disease from beginning to end, without nephrectomy. The time mentioned means simply the time during which the patient suffered from appreciable symptoms:

1 month or less	1
2 months	1
3 "	6
4 "	3
5 "	2
7 "	5
8 "	1
9 "	2
1 year	2
2 years	1
Total	24

The extreme malignancy of the disease is shown by the following table, which gives the duration of the disease from the beginning to the end, nephrectomy intervening. These patients did not die immediately after the operation was performed.

1 month or less	4
2 months	3
3 "	2
6 "	2
7 "	5
8 "	1
9 "	1
10 "	1
1 year	4
2 years	1
Total	24

Ordinarily the cause of death is cachexia. The patient gradually fails and dies of exhaustion. Occasionally some intercurrent disease carries off the patient. Uremia is sometimes the cause of death, but this rarely occurs. As metastases are relatively infrequent, death is seldom caused as a result of extension of the disease in some other organ of the body; but this occasionally does occur, and in these cases death is hastened.

Diagnosis.—A rapidly growing tumor in the lumbar region of a child, with symptoms of emaciation and cachexia, especially if hematuria has occurred at some time during the course of the disease, usually means tumor of the kidney. In the absence of hematuria, a rapidly growing mass may easily be malignant disease of the retroperitoneal glands. In the latter affection the differentiation is aided by noting the position of

the growth. Tumor of the kidney has a lateral position, while the glandular growth is centrally located, and it has a zone of sonority around it. A restless child who will not readily submit to examination had better be etherized, so that the physical examination may be thorough.

An early hematuria without tumor is exceedingly difficult to diagnose correctly. Here the examination of the urine is occasionally of great assistance. Occasionally it will be possible to separate the urine intravesically by means of a small-sized Luys' separator. In certain diatheses crystals are found in the urine which may, very exceptionally, irritate the kidney to such an extent as to cause a severe attack of hematuria. Proper treatment will usually cause the symptoms to disappear. At the same time it should be remembered that hematuria without an appreciable tumor occasionally occurs, and in such a case the greatest precaution should be taken that a tumor may not escape observation through carelessness in neglecting to make sufficiently frequent examinations.

The hematuria of acute nephritis subsequent to infectious diseases should be borne in mind, but in these cases a thorough examination of the urine will easily clear up the diagnosis.

Renal tuberculosis in the child is of very rare occurrence, but its existence should be thought of. The usual tests for isolating the bacilli will make the diagnosis plain.

Tumors of the bladder in children are extremely rare, but they should be borne in mind. Cystoscopy is not always possible, but local symptoms with disturbances of micturition point to the site of the trouble. In a case in which there is tumor in the kidney region, without other symptoms, a diagnosis may long remain obscure.

Splenic enlargement due to malaria, leukemia, and syphilis will have to be differentiated. It is well to remember that the anterior border of the spleen is sharp, and that there is no zone of tympany between the tumor and the spinal column, and that the colon does not pass in front of the spleen. An examination of the blood will very frequently lead to the correct diagnosis.

Hydronephrosis is very rare in children. It develops slowly and does not reach the large size of renal growths. It is occasionally accompanied by colic, and sudden changes in the size of the tumor may take place.

Ovarian tumors are so rare in children that they may be practically disregarded, and the same is true of echinococcus.

Tumors of the liver are very rare in children. In such cases jaundice is apt to be present, but here one must be on the lookout that a tumor under the ribs, accompanied by jaundice, is not a renal growth which

has compressed the bile duct. Liver enlargements do not give ballottement, and the anterior border of the liver is quite marked and extends in a lateral line across the abdomen. Tuberculous peritonitis in the child is not of great rarity, and is sometimes quite difficult to differentiate. The presence of fever is not a differentiating feature, because it is sometimes seen with tumors in the kidney. The presence of fluid in the abdomen is possible with both diseases, and it is at times impossible to differentiate the two. The family history may be of assistance here, and so likewise is the occurrence of tuberculous foci in some other part of the child's body.

Treatment.—Some years ago operation was not performed for tumors of the kidney in children, because the operative mortality was so great and the risk of recurrence so considerable. In later years, however, with a better and earlier selection of cases, the mortality of the operation has been very much reduced.

A condition of general weakness is a decided bar to contemplated operation; so likewise is the presence of metastases in other parts of the body. The opposite kidney should be examined with the greatest care, for, as we have seen, bilateral involvement is not so unusual that it can be totally disregarded. A small tumor, of course, offers the best chance of thorough removal, and in view of the local character of the disease, it would seem as though small tumors offer less chance of recurrence than larger ones. Nevertheless, large tumors have been removed and the results have been gratifying. For instance, Abbe[78] removed a large tumor weighing seven and one-half pounds from a female infant a year and a half old, and the patient survived the operation and was well one year later. There is great danger that the tumor may be inoperable because the family have waited too long before making up their minds to have the operation performed. The mildness of the symptoms in many of the cases sometimes causes timid people to defer an operation which is manifestly urgent.

With small tumors, the lumbar extraperitoneal incision will be selected, and, if possible, the peritoneal cavity will not be opened. Nowadays however, with improved technique, there is not so much risk in opening the abdominal cavity, and this route does not offer more risk than the lumbar. Albarran and Imbert,[79] in a list of 24 cases operated upon by the lumbar incision, noted 7 deaths, or 28 per cent., while in 76 cases operated upon by the abdominal route there were 20 deaths, or 26 per cent. These authors state that the high mortality by the lumbar route was probably due to the fact that an attempt was made to remove tumors of considerable size through an extraperitoneal incision; in such cases the operation is unusually difficult.

If the abdominal route is selected, that incision should be selected which will give the most room. An incision beginning a short distance from the spinal column, parallel with the rib and a little below it, and extending toward the median line, will usually give sufficient room. Many operators prefer the vertical Langenbuch incision, believing that there is less danger of permanently damaging the muscles than if the transverse incision is used. The Trendelenburg posture is sometimes of great assistance in exposing the field, and it is also of service because it keeps the blood in the region of the vital organs of the body during the operation; this is of considerable importance if there happens to be a hemorrhage during the course of the operation, an event which is not unlikely to happen if the tumor is very vascular and has large blood-vessels. Great care should be exercised to avoid loss of blood, and clamps should be freely used. These clamps may be left on, if necessary, until clotting has taken place, and they may be removed in from two to five days after the operation.

The patient should be well stimulated after the operation has been completed, and the best method is by means of brandy and coffee injections per rectum. An inclined position should be maintained until the operative shock has passed.

The immediate mortality of the operation, according to Döderlein and Birch-Hirschfeld,[80] is 40 per cent., and these authors state that death, in most cases, was due to shock, peritonitis, and hemorrhage. Walker[81] gives a mortality of 36 per cent. in 74 operative cases. Albarran and Imbert[82] find that the mortality is progressively less the later the statistics. Their table, which is as follows, shows this very clearly:

	Cases.	Deaths.	Per cent.
From 1876 to 1890	34	18	52
" 1890 " 1895	32	7	21
" 1895 " 1902	90	23	25

It is surprising how well little babies stand a severe operation of this kind, even if they have lost a considerable amount of blood. An incomplete operation, however, is very fatal, most of the patients dying almost immediately. Large tumors are difficult to remove, especially in the presence of adhesions. Albarran and Imbert,[83] in a list of 41 cases in which the age was two years and under, found 5 operative deaths and 36 recoveries.

The disease is very apt to recur even after a most thorough operation, the recurrence taking place within a very short period of time. In most of the cases reported death has been due to recurrence; in some an intervening complicating disease has carried the patient away. Walker[84] gives six months as the average length of time intervening between oper-

ation and recurrence when it does take place. Albarran and Imbert,[85] in a list of 42 cases, found recurrence occurring as follows:

6 months	29
6 months to a year	10
3½ years	1
4 "	1
5 "	1
Total	42

In the writer's table practically the same results were obtained as is shown by these figures:

1 month or less	2
2 months	5
3 "	5
4 "	3
5 "	..
6 "	2
1 year	1
Total	18

Albarran and Imbert,[86] in a list of 92 survivals of the operation, state that 81 per cent. of them suffered a recurrence, and they state that the general mortality, which includes death from operation and death subsequently, is in the vicinity of 86 per cent. Walker[87] places it still higher—93.22 per cent.

In estimating the number of actual cures following the operation, it is well to remember that recurrence may occur even a considerable length of time after the operation has been performed.

It is very difficult to estimate the total number of cures from recorded figures, because end-results in cases of survival have not, in the majority of instances, been given. The following are the only two well-authenticated cases that have been reported as surviving after three years: Schmid's[88] case, in a male, six months old, who survived the operation three years, and was still well; Muus'[89] case, in a male, nine months old, who survived nephrectomy, and was well three years afterward. Other cases, to the number of four or five, reported as survivals of three or more years' duration, by various authors, were found on investigation by the writer to be instances of hypernephroma.

Albarran and Imbert[90] have estimated positive cures at 12 per cent., but they have based this opinion, not on actual survivals, but on the probable outcome of survivals in which recovery from the operation took

PLATE XXXVIII.

ANGIOMA OF A RENAL PAPILLA WHICH BLED CONTINUOUSLY FOR TWO YEARS.
OPERATION. CURE. ([illegible])

place, and which were reported as "cures" of a few months to two or three years' duration, most of them being survivals of a few months' time.

TUMORS OF THE RENAL PELVIS AND URETER.

Etiology.—Israel[91] had 2 cases of renal pelvic tumor to 68 of the renal parenchyma. In 94 cases of renal and perirenal growths occurring at the Massachusetts General and Boston City Hospitals in ten years there was but 1 case of renal pelvic tumor, a papilloma.

The growth is commonest between the ages of thirty-five and sixty, and males are somewhat more disposed to the affection. Calculus appears to be an exciting cause in some of the instances, and Albarran and Imbert[92] found 8 in their 53 cases, or 15 per cent., in which calculus was an exciting cause.

Pathology.—The following growths are found in the renal pelvis and ureter:

1. Epithelial growths:
    - Papilloma.
    - Papillary epithelioma.
    - Epithelioma (non-papillary).
2. Mesodermal growths.

There are a few growths not included in the above table. Grohé[93] has described an adenocarcinoma of the ureter, and so also have Metcalf and Safford.[94] In the latter case there was a calculus in the ureter, and this seemed to have been the exciting cause of the growth. Hektoen and Riesman[95] have described a tumor of the ureter resembling adenoma. The ureter having no glands, this tumor was explained as springing from "rests" of the Wolffian duct.

Fenwick[96] has reported a unique case of angioma of a renal papilla, which was cured by nephrectomy. The growth was of small size, and on microscopic examination was found to consist of small dilated blood-vessels running in the papilla. Many of the larger vascular channels were distended with clot. Fenwick,[97] however, was uncertain as to the nature of the change, and hinted that it might have been due to localized chronic interstitial nephritis. (Plate XXXVIII.)

1. EPITHELIAL GROWTHS.—*Papilloma.*—This tumor is the commonest of those affecting the pelvis and ureter. In Albarran and Imbert's[98] series of 54 cases of primary tumor, in 22 there was a pure papilloma. The growth may originate in the ureter or in the pelvis, but it is more frequent in the latter situation. A growth starting in the pelvis may spread to the ureter by metastasis, and vice versa. Further-

more, a growth may recur in the ureter after removal of the kidney affected by the primary tumor. Fenwick[99] records the case of a man, aged seventy years, who had his kidney removed for papillomatous disease. Recurrence took place in the ureter of the affected side a year later.

The structure of the growth is that usually found in papilloma of mucous membranes. The chief characteristic are tufts which are made up of large numbers of small villi, closely packed together. Each villus is composed of a small central vessel, around which the cells are placed in rows several deep (Fig. 393). The tumor is in direct contact

Fig. 393

Simple papilloma of the renal pelvis, showing the papillary arrangement of the growth. Small bloodvessels traverse the centre of the papillæ and around these vessels the tumor cells are arranged. (Pathological Laboratory at the Boston City Hospital.)

with the membrane of the pelvis or the ureter. Occasionally the growth does not take the form of isolated tufts, and it occurs as groups of small villosities, giving the membrane a velvety appearance.

This form of tumor is called benign, but it has a decided tendency to become malignant in the course of time, and the majority of observers are now agreed that it should be reckoned as a malignant growth. When it becomes malignant, the tumor begins to grow in a downward direction, invades the tissue beneath, and gives rise to metastases.

Papillary Epithelioma.—This tumor is really only a later stage of the tumor just described. It has the appearance of vascular tufts exactly

like the preceding tumor, but in the deeper layers of the growth there is a distinctly epitheliomatous structure with cylindrical cells, and there is a more or less alveolar aspect. The growth has all the characteristics of cancer, and spreads by continuity and metastasis. A peculiarity of the disease is that a simple papillary growth may be present in the ureter, while at the same time there may be a distinctly malignant epithelioma in the pelvis of the kidney. The growth, which is apparently benign on its removal, may recur in the malignant form many years afterward. Tikhoff[100] records a case in a man, forty years of age, who had a kidney removed for apparently benign villous papilloma of the pelvis. He lived for ten years in good health, and then there was a recurrence in the scar as a medullary carcinoma.

Epithelioma (non-papillary).—Occasionally, though rarely, epithelioma of the squamous-cell variety is seen. Kundrat[101] first called attention to this tumor. The growth may arise either in the pelvis or the ureter, and has the appearance of nodes infiltrating the walls. Hallé[102] is of the opinion that these cancers may become engrafted upon plaques of leukoplakia, which are occasionally found in the mucous membrane of the urinary tract, and he believes that calculous or other forms of inflammation may be the starting point of this leukoplakia.

All forms of malignant disease of the pelvis and ureter behave in exactly the same way. If the ureter is occluded, secondary hydronephrosis is sure to follow. The presence of blood in the urine in these renal sacks is the usual rule, on account of the ready tendency of the growth to bleed. The ureter above the growth likewise becomes dilated and may sometimes be felt as a thick cord through the abdominal wall.

Strictly localized ureteral growths are exceedingly rare, and a careful search of the literature discloses only fourteen cases.

Symptoms.—The chief symptoms are, as in the case of renal growth, pain, hemorrhage, and tumor. The pain is apt to come on in attacks of colic at unexpected times. This happens when the ureter becomes occluded by a clot. The hematuria is usually painless in character, unless there is a clot formation, and then there may be intense pain. Vesical symptoms are experienced when there is clot formation in the bladder. Ureteral clots are very characteristic. They have the appearance of angle-worms and are sometimes of great length. The bleeding may be intermittent or continuous, and may extend over a period of many months, and sometimes years. Heaton and Gamgee[103] record the case of a man, forty-eight years of age, who had his first attack of hematuria nine and a half years before the operation. A marked feature of the hematuria is that when it subsides there may be a noticeable increase in the size of the renal tumor. This is caused by the blocking of the ureter with a clot, with obstruction to the flow of urine, and a subse-

quent condition of hematonephrosis. This symptom is of diagnostic importance. Occasionally hematuria may be absent during the whole course of the disease.

The renal tumor is due both to the collection of fluid distending the pelvis and also to the presence of the growth itself. A small growth situated at the site of the ureteral orifice in either the pelvis of the kidney or the opening in the bladder may, by occluding the canal, give rise to an exceedingly large tumor, due entirely to distention of the pelvis with accumulated urine.

The changes in the urine are not important, except for the presence of blood. Fragments of villi and numerous epithelial cells are of great diagnostic importance, but the villi are seldom found.

The general symptoms of the disease depend upon its stage. In the early part of the trouble the general health is but slightly affected. Once, however, the tumor has begun to grow, especially when it has invaded neighboring organs and has given rise to metastases, general symptoms of weakness, loss of appetite, pallor, and loss of flesh will be noted. The termination by exhaustion or from uremia is common. Occasionally the disease ends in consequence of extension of the growth to some neighboring organ. Thus it may travel to the lung and cause hemothorax, and end life in this way.

A great deal of information may be obtained by cystoscopic examination. The bladder is frequently the site of a villous tumor, and these growths may be either secondary or primary. If a villous tumor is found in the bladder, in a case in which there are symptoms pointing to the kidney and ureter, this is evidence that the disease in the upper passage is of the same nature as that in the bladder. Occasionally a small growth will be seen extruding from the mouth of the ureteral orifice. A villous tumor in the bladder which involves the ureteral orifice and gives rise to symptoms of renal retention is very puzzling with reference to the existence of a growth higher up, and a diagnosis of growth in the upper passage cannot positively be made in such a case. The exact location of a tumor in the ureter is extremely difficult to determine. Fenwick[104] has called attention to a very important sign in cases of renal pelvic growth. He has noticed that the ureteral orifice is altered on the affected side in cases of growth in the pelvis of the kidney in which there is pelvic dilatation; this alteration is in the nature of a dull-colored swelling, and elongation of the opening of the ureteral orifice, resembling a swollen meatus of a male urethra. In other cases he has noticed the orifice to be of normal size, but the edges roughened and the interior colored a dull red. The latter condition is especially seen just after a recent profuse renal hemorrhage.

Fenwick states, however, that this roughened appearance is not a constant feature, and that the orifice may be of perfectly normal appearance even after a severe hemorrhage. He concludes, therefore, that this appearance is probably caused by mechanical injury due to the passage of clots.

Diagnosis.—It is almost impossible to make a correct diagnosis of tumor of the ureter or the renal pelvis. The clue to the diagnosis is furnished by renal tumor, hematuria, and by isolating, with the renal catheter, urine from the pelvis of the kidney, in which urine there are numerous typical cells. The cells are usually cylindrical or pavement, according to the character of the growth, but their presence is significant only in the absence of chronic pyelitis; in the latter affection cells of the same character may be found; the distinguishing feature in malignant growth is the absence of pyuria.

The changeable character of the tumor with reference to its size has already been mentioned, and also the intermittent character of the hematuria and its association with renal colic. Tumor of the renal parenchyma seldom changes its volume, and it has the feeling of a solid mass rather than a sac of liquid. The cystoscope sometimes gives information. The presence of a tumor at the ureteral orifice is very suggestive of growth higher up.

Intermittent hydronephrosis, especially if there is hemorrhage, should always make one suspect tumor of the renal pelvis. It is well to bear in mind, however, that simple hydronephrosis may be accompanied by hematuria. Calculus rarely gives rise to secondary hydronephrosis, and hemorrhage with calculus is seldom as abundant as it is in the case of new-growth.

Fenwick[105] has described two unusual cases of hematuria. At an exploratory nephrectomy the bleeding was found to proceed from a renal papilla and the mucous membrane covering it. In both cases the condition was found to be due to a localized form of interstitial nephritis.

There are no characteristic symptoms or signs which point to a tumor of the ureter alone. Enlargement of the Fallopian tube, especially if the tube is near the bladder, may be mistaken for tumor of the lower end of the ureter. Albarran[106] calls attention to this point, and relates a case in which salpingitis was mistaken for tumor of the ureter. This diagnosis seemed not improbable in view of the fact that there was a small growth presenting at the orifice of the ureter in the bladder. It was only at the operation that the mistake was discovered.

Prognosis.—Papilloma of the renal pelvis may exist a considerable length of time in the kidney, even months or years, in an apparently benign form, and during this time the general health may not suffer at all, or, at the most, not very appreciably. A number of years may

elapse before nephrectomy is done, and during this time the patient may not have any further symptoms than occasional pain in the region of the affected side. In these long-standing cases an attack of hematuria may occur, and this symptom may not recur for many months. As the disease progresses, malignant degeneration is apt to take place, and the clinical aspect is at once changed. The disease is then not different from the usual forms of malignant disease of the kidney; rapid emaciation may occur, and if an operation is not performed the patient soon succumbs.

Treatment.—It has been generally agreed that the only proper treatment is total nephrectomy combined with ureterectomy. This applies not only to those tumors which are evidently malignant, but also to the apparently simple papillomatous tumors. It is necessary to remove the ureter on account of the well-known disposition of the disease to return in the ureter, even after the kidney has been removed, the recurrence possibly not taking place until many years afterward.

The treatment of a growth affecting the lower part of the ureter will depend upon the extent of the disease. If the kidney is enlarged from renal retention, nephrectomy, as well as ureterectomy, is required. In cases in which the lower end of the ureter is diseased, without enlargement of the kidney above, the line of procedure will depend upon the extent of the lesion. If a small growth presents in the bladder it may be excised through a cystotomy wound. If on examination with the catheter the rest of the ureter is found to be free from disease, nothing further need be done. If the tumor is not extensive, and preserves its rounded form, it may be possible through a cystotomy wound to remove the tumor, taking with it an elliptical portion of the bladder around the ureteral orifice, and the operation may be completed by implanting the ureter in the vesical wound. This operation has been performed, the tumor excised, and the patient, an adult male, lived in a perfect state of health for six years afterward, and then died from suicide (Albarran and Imbert[107]). Should the disease be extensive and be accompanied by peri-ureteral enlargement the ureter must be attacked by an extraperitoneal incision. If the growth has involved the bladder, a portion of this organ may be excised. After removing the diseased portion the operation is terminated by implanting the ureter into the bladder, or possibly into the ureter on the opposite side. Should the kidney require removal, this may be done at the same sitting, or at a later time. In aseptic cases the end of the ureter is tied securely, while in septic cases it is allowed to drain externally.

The immediate results of operation for simple papilloma are good. There is always great danger, however, of recurrence of the disease, either immediately or within a few months or years after the operation.

Reports of end-results following nephrectomy for simple papilloma are very few, and the following five cases are the only ones that could be found in an extensive review of the literature:

CASE I.—Fenwick's[108] case, in a male, aged seventy years, who had the right kidney removed for this disease. There was a recurrence at the end of a year in the right ureter, and this was removed. The patient died uremic four years later; toward the end there was carcinoma of the prostate and squamous-cell cancer affecting the nephrectomy scar.

CASE II.—Fenwick's[109] case in an adult male, who had the disease in the right kidney. Nephrectomy was performed and the patient was well five years later.

CASE III.—Heaton and Gamgee[103] report the case of a patient, a male, aged forty years, who had been suffering for nine years. The kidney was removed, and there had been no recurrence up to the time of the report, nine months after the operation.

CASE IV.—Le Dentu and Albarran[110] report a case in a male, aged thirty-three years, who had suffered from symptoms covering a period of four years. Nephro-ureterectomy was performed, and there had been no recurrence fourteen months after the operation.

CASE V.—Tikhoff[100] reports the case of a male, aged forty years. The symptoms were supposed to have extended over a period of twenty years. Nephrectomy was performed, and this was followed by a period of ten years during which there was perfect health. At the end of this time there was a recurrence in the scar as medullary carcinoma, and death followed in six months.

These cases are too few in number to enable us to draw any positive conclusions. They illustrate, however, the seriousness of the disease and how grave is the danger of recurrence.

The following nine cases of papillary epithelioma are interesting because the end-results are given:

CASE I.—Fenwick's[111] case of a male, aged fifty-nine years. The kidney was removed and the disease recurred as carcinoma of the liver six years later, and caused death.

CASE II.—Fenwick's[112] case, in a male, aged forty years. The kidney was removed, and the patient died six months later from recurrences in the loin, groin, and supraclavicular glands.

CASE III.—Israel's[113] case, in a male, aged fifty-two years. Nephrectomy was performed, and there was no recurrence a year later.

CASE IV.—Albarran and Imbert's[114] case, in a male, aged forty-five years. A transperitoneal nephrectomy was performed, and there had been no recurrence six months later.

CASE V.—Grohé's[115] case, in a female, aged thirty-seven years. A transperitoneal nephrectomy was performed, and the patient died eight months later from the effects of the disease.

CASE VI.—Reynès'[116] case, in a male, aged thirty-two years. Nephrectomy was performed, and there was recurrence in the bladder a year later.

CASE VII.—Albarran's (see Heresco[117]) case, in a male, aged thirty-four years. There had been no recurrence at the time of the report, which was written four years after the nephrectomy.

CASE VIII.—Pantaloni's[118] case, in a male, aged forty-nine years. Nephrectomy was performed, and recurrence took place six months later.

CASE IX.—Drew's[119] case, in a male, aged fifty-six years, who died four months after nephrectomy.

We see on glancing at the list of cases that most of them had rapid recurrence.

The squamous-cell epitheliomata are very fatal, most of the patients dying soon after the operation. There is but one case in which recovery took place, that of Giordano,[120] in a female, aged fifty-seven years, who had nephrectomy performed for this disease. The woman was well six years later.

POLYCYSTIC KIDNEY.

Etiology.—The influence of heredity appears to be marked in some instances, and the affection is sometimes seen in members of the same family. The disease is one of middle life, and most cases occur between forty and fifty years of age. Seiber,[121] in an analysis with reference to this point, finds the following results:

	Cases.
20 to 29 years	26
30 " 39 "	22
40 " 49 "	67
50 " 59 "	40
60 " 69 "	10
70 " 79 "	6
80 " 89 "	2

To this list we may add Boinet and Raybaud's,[122] of 35 occurring during infancy:

At term	14
8 months	16
7 "	4
6 "	1
Total	35

PLATE XXXIX

TYPICAL POLYCYSTIC KIDNEY. (Watson.)

PLATE XL

POLYCYSTIC KIDNEY. INTERIOR OF THE KIDNEY. (Watson.)

A peculiarity of the disease is that it seldom occurs between the period of infancy and twenty-one years. Instances, however, occasionally do occur. Thus, Seiber[123] was able, in a list of 212 cases, to collect 33 occurring during this period of life.

The disease has a tendency to affect women more frequently than men. In Seiber's tables, in 198 cases in which the sex was given, there were 116 females and 82 males. It was curious to note that in the operative cases the proportion of females is much larger; thus, Seiber found 60 case of women and 10 cases of men. Albarran and Imbert[124] find the same result; in their list of operative cases there were 35 females and 4 males. There seems to be a slight preference for the left side, for in Seiber's 9 cases in which the disease was unilateral, the left side was affected six times and the right three times. Among his operative cases, also, this preference for the left side is noted, for in a list of 46 cases in which operation was performed, twenty-eight times the left kidney was operated upon, and eighteen times the right one.

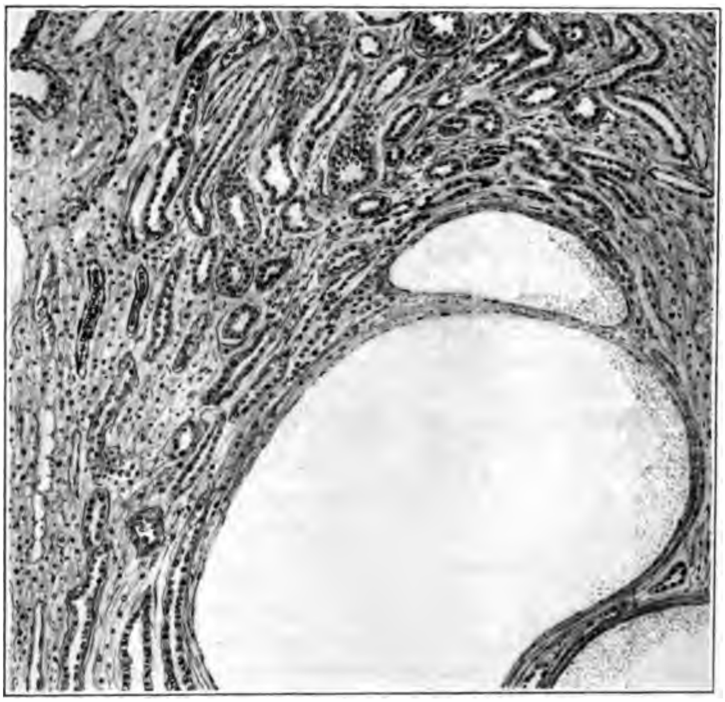
Pathology.—Polycystic kidney is a very rare disease. Preitz,[125] on examining the records of the Pathological Institute of Kiel, found among 10,000 autopsies only 16 cases of polycystic kidney. In the records of 2429 autopsies occurring during the last ten years at the Boston City Hospital, there were 10 cases.

The tumor is made up of a greater or smaller number of cysts, which are scattered about in the substance of the renal parenchyma. (Plates XXXIX and XL.) These cysts are of variable size, some being microscopic, and others from 0.5 to several cetimeters in diameter, and even occasionally much larger. These larger cysts are formed by fusion of the smaller ones, and, exceptionally, they may hold from one to several ounces of fluid. The tumor usually preserves the characteristic shape of the kidney to a more or less degree, and sometimes attains to enormous dimensions. In the case of double cystic kidney occurring in the practice of Dr. H. T. Baldwin, of Brookline, Mass., the right kidney weighed 4370 grams, measuring 33.5 cm. in length, 18 cm. in width, and 12 cm. in thickness; the left kidney weighed 5270 grams and measured 34 cm. in length, 19 cm. in width, and 13 cm. in thickness. The patient's mother had died from the same affection.

The cysts are closely packed together, invade every portion of the kidney, and the organ, viewed in the gross, is not unlike that of a bunch of grapes. The number of cysts is variable, and they have a tendency to develop on the anterior surface of the kidney, pushing the hilus posteriorly. The walls of the cyst are generally quite thin (see Fig. 394), and inside of them are sometimes seen the remains of septa which mark the places where coalescence with neighboring cysts has taken place. The

contents of the cysts vary, being sometimes clear, pale straw-colored, bloody, or dark brown. This fluid may be viscid, turbid, colloid, pea soup-like, serous, or limpid and transparent. The kidney substance between the cysts is compressed and may be very fibrous or hyaline. In some instances there may be a very considerable increase in the amount of tissue. Occasionally the perinephric tissue is the seat of an abscess, and in these cases suppuration of the cysts has also taken place. The renal pelvis may become dilated, and when this occurs it is usually due

FIG. 394



Microscopic section of a polycystic kidney.

to misplacement of the kidney, with torsion of the ureter and consequent hydronephrosis. A fibrous change around the hilus of the kidney has also occasionally been observed, which is sometimes so extensive as to transform this portion into a dense fibrous mass.

These tumors are most frequently bilateral in the adult, as in the forms seen at birth. Lejars[126] found only 2 cases among sixty-three adults in which the disease was unilateral. Seiber,[127] in an analysis of 149 cases, found only 9 in which the disease was unilateral.

Malformations in other organs in association with cystic disease in the adult are not seen, as in the cases of polycystic kidney of the congenital

variety occurring at birth. Cystic disease of the liver, however, is sometimes seen in the adult with polycystic disease of the kidney.

Under the microscope the cyst wall is seen to be made up of fibrous connective tissue, and it is lined with epithelium which in places appears to be undergoing proliferation; where this proliferation is most pronounced there is an appearance of papillary buds, giving a distinct papillary appearance. The epithelium itself is cylindrical in places; in others, it is more flattened and cuboidal. The cyst wall is in direct contact with the parenchyma of the kidney, which it has altered in process of growth. Floating about in the cyst fluid are numbers of epithelial cells, sometimes in enormous quantities. It was the presence of these large numbers of cells that first gave Brigidi and Severi[128] the idea that the process must be due to new-growth, as evidenced by proliferating epithelium. Urinary constituents are occasionally detected in these cavities, but never pure urine; urea, calcic oxalate, albumin, chlorides, phosphates, uric acid, cholesterin, and leucin are sometimes found; the presence of a small amount of blood is not exceptional. The renal parenchyma between the cysts undergoes great changes. There is localized nephritis, having the usual character of interstitial inflammation, and this change is especially marked in the region of cysts which are of large size, where compression has been considerable. Pictures of sclerosis and atrophy are likewise seen under the microscope, and there are evidences of inflammation of the arteries. The urinary tubules and glomeruli are greatly compressed and atrophied. In advanced cases the interstitial tissue has taken on a dense appearance, in which nothing is to be distinguished but connective tissue in which renal elements are entirely absent. In areas where the cysts are numerous and the compression not extensive, there may be renal tissue which is still capable of performing its physiological function.

The interstitial changes in the kidney are essentially those seen in ordinary cases of chronic interstitial nephritis. Secondary hypertrophy of the left ventricle of the heart, and likewise arteriosclerotic changes are very frequent, and occur in about three-fourths of the cases.

The occurrence of cysts in the liver at the same time with polycystic kidney has been noted in a number of instances. Cystic disease of the liver rarely occurs alone. Moschowitz[129] was able to find but 10 cases in which the liver lesion was the only one, the others being associated with cystic kidney. Lejars,[130] in a series of 63 cases, found 17 (5 in men and 12 in women) in which there was co-existing cystic disease of the liver. Cystic disease of other organs in association with polycystic kidney occurs much less frequently. In 3 of Seiber's cases both ovaries were affected; in 3 other cases, one ovary; in 3 cases, there were cysts of the choroid plexus; in 1 case, of the epididymis; in 1 case, of the

broad ligament; in 1 case, of the uterus; in 1 case, of the bladder; in 1 case, of the ureter; in 1 case, of both ureters; and, finally, in 1 case, of the renal pelvis and calices.

Cystic changes in the liver are particularly seen in adults; they are almost never seen in infancy, at least not the macroscopic form. The walls of these liver cysts are formed of connective tissue lined with epithelium. These liver cysts are sometimes microscopic in size, and at other times very plainly recognized by the eye. They are usually not numerous, and do not, as a rule, interfere with the function of the organ. Occasionally, however, they may enlarge the liver to a considerable size. Lund[131] mentions a case in a female, aged forty-seven years. In this case there were double cystic kidneys of large size, and also cystic disease of the liver. The latter organ extended 5 cm. below the border of the ribs, and was everywhere filled with cysts.

The occurrence of these cysts in the liver at the same time with cystic disease of the kidney is strongly suggestive that they may have a similar origin. Albarran and Imbert[132] are of the opinion that these cysts develop at the expense of the biliary epithelium, and that the process is possibly that of a new-growth, an adenocystoma of the biliary passages. Suggestive of the theory that they may be due to malformation is the fact that, independently of polycystic kidney, they have been found associated with malformations of the body, though not so frequently as in the case of polycystic kidney. Convincing evidence that the liver cysts are due to congenital malformation has been furnished by Moschowitz,[133] who describes the liver of a fœtus which came under his observation. In this case there were double cystic kidneys, meningocele, and there were supernumerary fingers and toes. The liver was of normal size, and appeared to contain no cysts; but on microscopic examination the organ was found to contain multiple primary aberrant bile ducts. Moschowitz was strongly of the opinion that, inasmuch as the fœtus had other malformations, these aberrant ducts must have been a congenital malformation, and he regarded them as a first stage of cystic disease.

Pathogenesis.—The pathogenesis of polycystic disease of the kidney in the adult is involved in great obscurity. It would appear that the disease must have the same pathogenesis in the adult and in infancy, and yet there are features which are dissimilar at the two ages. The fact that the disease is so infrequent between infancy and the age of twenty-one makes it difficult to understand how it is possible that influences acting at birth can have any bearing on a disease occurring so many years afterward. In the adult it seems fairly certain that in some cases, at least, the cysts do not date from fœtal life. The cysts in the adult appear to develop in large part in the convoluted tubules; this

appears to be the case from the fact that in the slighter forms of the affection most of the cysts are found in the cortex.

The following theories have been evolved to explain the pathogenesis of polycystic kidney in the adult: (1) the theory that the process is a new-growth; (2) the theory that the process is the result of inflammation and sclerosis of the interstitial tissue between the tubules; (3) the theory that the process is due to malformation, and consequently must be congenital; (4) and, finally, there are some who combine these theories together, and who would explain the origin of polycystic kidney as the result of both malformation causes and subsequent tumor formation.

Malassez[134] first conceived the theory of new-growth, but Brigidi and Severi[128] were its chief exponents. These last authors believed that the cyst contents were nothing more than the protoplasm of the epithelial cells fused together. They thought that they could observe nuclear division of the cells. They also thought that they could see young elements in the tubules and in the smaller cyst cavities, and papillæ covered with several layers of epithelium. They compared the affection to ovarian cystoma, and they believed that the disease in the kidney was a true cystoma. Nauwerck and Hufschmid[135] were also exponents of this theory, and they stated that they found papillary projections filling the lumina of the tubules, which they considered to be the beginning of a papillary growth. Ritchie[136] was of the opinion that the process was one of new-growth, but he thought that the disease in childhood and in the adult entirely distinct, believing that the adult cystic kidney is to be classed with the adenomata, while the congenital variety should be considered an error in development.

The theory that the disease is caused by inflammation of the interstitial tissue found its first exponent in Virchow,[137] who believed that the cysts were true retention cysts, and that they resulted from occlusion of the urinary tubules in consequence of inflammation of the interstitial tissue in the papillæ of the kidney. This view has been entirely abandoned. This inflammation is seldom found in infancy, and is almost never seen in adults. The interstitial inflammation is now regarded as a sequence of the disease and not a cause.

The theory that the disease is in all cases congenital and is in the nature of a malformation, has found many adherents. Koster[138] was the first to suggest this explanation. The difficulty in accepting this theory for adult cases is the fact that for so long a period of time between birth and adult life the disease so seldom occurs. The fact that the disease occurs in many cases in members of the same family suggests some intra-uterine influence. On the other hand, malformations of other organs than the kidney are exceedingly rare in the adult, while they are not so uncommon in infancy.

Busse[139] believed the disease in both infancy and in the adult to be derived from disturbance of development, but that in the adult the grade of this disturbance must be slighter than in the congenital form. He thought that there was an arrest of development in the sense that perhaps, in consequence of an overdevelopment of connective tissue, the tubules and the glomeruli could not get into relation with each other, and that each developed independently in an abnormal way.

If we examine into the embryology of the kidney, we shall see that there is good reason for supposing that malformation causes may be, in part at least, the origin of the condition. Huber[140] has definitely shown that the fully developed tubule, that is, from its beginning in the glomerulus to its exit in the renal pelvis, is, in the first instance, formed from two separate structures. In early embryonic life there is formed a renal vesicle and a primary collecting tubule. The vesicle is situated at the outer side of the tubule. Later, union takes place between these two structures, with the formation of a single canal. It is easy to see that if union failed to occur a cystic condition might result in the tubule which did not have an outlet.

These different views of the origin of the disease are confusing, and there exists no uniformity of opinion. The most plausible explanation seems to be that the disease may originate in consequence of embryonic malformation, and that subsequent neoplastic formation takes place. The interstitial changes and the compression caused by cysts themselves still further tend to augment the size of the cysts.

Symptoms.—When the disease has begun in utero, the suspicion may be entertained that it is present by an unusually large size of the mother's abdomen. During labor it may be the cause of delayed birth, and instruments or some mutilating operation may be required to deliver the child. Premature labor is not uncommon. Boinet and Raybaud,[141] in a list of 25 cases, report 12 deaths immediately after birth, and 10 soon after. If the child survives, the symptoms noted are those due to pulmonary embarrassment, diarrhœa, general exhaustion, and marasmus. The child leads a wretched existence until relieved by death. The end is usually by coma or convulsion.

The disease in the adult is very insidious in its onset. It may exist in latent form for many months, or even years, without giving rise to any symptoms whatsoever. The patient may go on in a state of perfect health, until suddenly symptoms of uremia come on and death ensues in a short time. Another ending, unexpected and unforetold, is by cerebral hemorrhage. Arteriosclerosis, a frequent accompaniment of polycystic kidney, is the cause of death in these cases. Albarran and Imbert[142] estimate that the disease is an autopsy finding in 25 per cent. of the cases.

Milward[143] divides the disease into three stages: The first stage is marked by progressive enlargement of the kidneys, and during this time there may be no subjective symptoms whatever, even for months or years; in the second stage, subjective symptoms are experienced, and objective signs are felt or seen by the patient or the physician, the duration of this stage being from a few months to several years; in the third stage there are marked signs due to the decreasing elimination of urea, and uremic symptoms are not infrequent. The last stage is the shortest, and lasts from a few weeks to a few months and ends in death.

The tumor, although more frequently bilateral than unilateral, is in most cases felt only on one side. Lejars,[144] in his series of 63 cases, noted tumor eighteen times only, and in these 18 cases, in only 3 of them was tumor found on both sides during life, although there was a double tumor in all 18 cases. When the tumor is bilateral the diagnosis is almost self-evident. The growth is sometimes of enormous size, and when both kidneys are affected the two tumors together may nearly fill the abdominal cavity. Compression of the intestines by the growth may interfere with the function of the bowels.

On examination there is a dull note over the mass, and in thin subjects palpation will frequently discover the botryoidal character of the tumor. The growth often gives a characteristic soft, yielding feel, but fluctuation is rarely present.

Pain is the most prominent symptom in the second stage. It is usually of a dull aching character, aggravated by exertion, and it is felt in the lumbar region and occasionally in the abdomen, at first at one side, and if the disease becomes bilateral, on both sides. Radiation is not uncommon. In the first stage of the disease the pain is paroxysmal, but later it may be continuous. The character of the pain may resemble renal colic, and in these cases this is probably due to the passage of blood clots. Hemorrhage in the cyst may be the explanation of the excruciating pain sometimes felt. Sometimes the pain is a very late symptom. Thus, Luzzatto[145] records a case in which severe pain appeared only five days before death.

The other symptoms experienced during the second stage are mainly those which are due to inefficient action of the kidneys, and to the general condition of arteriosclerosis. The clinical picture resembles closely that of chronic interstitial nephritis, with this exception, that in polycystic kidney œdema of the extremities is rarely observed. Ascites is also a rare symptom. Headaches, digestive troubles, flatulence, constipation, vomiting and dyspnœa are not uncommon. There may be also slight hemorrhages from the nose, gums, and bowels, and petechiæ may be seen on the surface of the body. A sudden severe cerebral hemorrhage may occur at any time and cause death, or leave the patient in a condition of

invalidism. The general health, however, may remain fairly good for a considerable period of time. Cardiac hypertrophy is not usually seen until late in the second stage.

The urine is generally acid, and is usually slightly increased in amount. In some cases there may be marked polyuria, the amount being as high as 7000 c.c. in twenty-four hours. The specific gravity varies from 1008 to 1020. Albumin is present in about one-third of the cases. The quantity of urea excreted depends upon the amount of normal kidney substance remaining. Casts are rare, in this respect differing from the urine of chronic interstitial nephritis. A severe attack of hematuria occurs, as a rule, every few months or every few years, and is a prominent symptom. Blood in microscopic quantities is almost always present, and constitutes a significant sign. Hematuria, however, does not possess the diagnostic importance that it does in malignant disease of the kidney.

The third stage of the disease is usually very short. There may be violent headache, severe dyspnœa, drowsiness, convulsions, and coma. The patient has a yellow color similar to that caused by cancer, and there may be bronzing of the skin. Emaciation may be pronounced; the patient's face is drawn and pinched, and his bodily strength is greatly reduced. Hectic fever has been noted a number of times. Death is very frequently due to anuria with uremia. Luzzatto[146] records this ending in 24 cases in a list of 38 in which the mode of death was given. Ascites and diarrhœa may hasten the end by exhausting the system. Among other causes of death may be mentioned cardiac failure, acute pulmonary œdema, pleurisy, bronchitis, bronchopneumonia, and pericarditis. Suppuration of the affected kidney, evidenced by pain, fever, tenderness, and severe systemic disturbances, has been reported in a number of instances.

It is difficult to determine the duration of the disease from the beginning to the end. It sometimes runs its active course within a few months. The disease may be recognized early and may last a very long time. Not infrequently cases have been reported in which the duration was ten or even twenty years. Usually, recognized cases last about five or six years.

Diagnosis.—It is difficult to make a correct diagnosis of the disease in the first stage when tumor alone is the first symptom. If there are two tumors the presumption is in favor of polycystic disease. The entire absence of symptoms in so many instances serves, in a measure, to differentiate it from malignant growth, although, as we have seen, malignant disease may remain latent for a considerable time without causing symptoms; hematuria, however, is more apt to occur in malignant disease than in polycystic kidney.

In the second stage the symptoms of renal insufficiency, such as headache, vomiting, slight hemorrhages, etc., are extremely suggestive, especially in the presence of tumor. If the urine under these circumstances is increased in amount, has a low specific gravity, and possesses other characteristics of chronic interstitial nephritis, this may lead to a correct diagnosis. The cardiac and arterial changes may likewise serve to indicate the character of the affection.

Hydronephrosis and pyonephrosis are sometimes mistaken for this disease. In these affections there is a sudden decrease in the size of the tumor when the sac is empty. A smooth-surfaced tumor which fluctuates is very suggestive of distention of the renal pelvis, and this feature is in direct contrast with polycystic kidney, in which fluctuation is seldom evident. In pyonephrosis we look for evidence of inflammation in the lower urinary passages.

Simple renal cysts of large size may be difficult to differentiate. The absence of general symptoms may serve to distinguish between the two, single cyst seldom giving rise to such serious disturbances as are seen in polycystic disease.

Prognosis.—The patient is always in danger of sudden death, either from sudden cessation of the urinary secretion or from apoplexy. Intercurrent diseases are likewise apt to occur, and if they do, the resistance of the body is much less than it is in sound constitutions. The disease has occasionally been observed in persons over seventy, and the presumption is that they harbored it a good while. Even after successful nephrectomy there is great danger of recurrence in the opposite kidney, and most patients succumb within a short time after this operation.

Treatment.—Patients with polycystic disease take anesthetics very poorly, and one always hesitates to perform an operation if it can be avoided.

Nephrectomy should never be done unless it is certain that the opposite kidney is free from the disease, and even in these cases the operation is not to be thought of unless there are severe disturbances. Symptoms of insufficient elimination of urea absolutely contraindicate the operation. Lejars'[126] statistics, showing that the disease was unilateral in only 2 cases among 63 adults, show how seldom one will be called upon to decide whether nephrectomy shall be done. Ritchie's[147] figures are corroborative, and he found but 2 cases in a list of 72 in which at postmortem examination there was unilateral disease. In the presence of double cystic kidneys it may sometimes be permissible to do nephrectomy if one side is bleeding profusely. Here one might be persuaded to take the risk of removing such a kidney, providing the disease on the opposite side were not too extensive.

Nephrectomy has been done in some cases, and with success. An unfortunate feature is that the disease is very apt to return in the opposite kidney after the operation, although it was apparently sound at the time of the nephrectomy.

The operation of election is the abdominal, for it allows of a thorough exploration of the opposite kidney.

Albarran and Imbert[148] report 34 nephrectomies, with 25 operative cures. Of these 25 patients, the end-results were known in 15. Two survived seven years; 1, six years; 4, three years, with probable recurrence; 2, two years, with probable recurrence; 1, twenty months, with probable recurrence; 4, one year; and 1 died several weeks after the operation. In Seiber's[149] tables there were 62 cases in which nephrectomy was done. In 61 of these the end results were given. Twenty ended fatally, most of them immediately after the operation. Forty-one survived; in 9 of these 41 cases there was recurrence in the remaining kidney a short time following the operation; of the remaining 32 patients, 1 was well five months after the operation; another, eight months; another, nine months; another, fourteen months; 2, after two and a half years; 4, after three years; 1, after five years; 1, after six years; and 2, after seven years; the remaining patients were not followed.

Nephrectomy has been successfully performed in infants. Three cases have been recorded. Roswell Park[150] did the operation on a male child, aged twenty-three months, in whom there had been a noticeable tumor for eleven months. The tumor, weighing four pounds, was removed and the child recovered. Death, however, took place some years later, in consequence of the same disease, which attacked the opposite kidney (Roswell Park[151]). Dalle Ore (quoted by Boinet and Raybaud[152]) also had a successful case in a child thirty months old. The end-result was not stated. Hildebrand[153] reported a successful operation in a case of congenital cystic kidney in a boy two years of age. There was no final history. The remarkable feature of this case was the unique nature of the tumor. The cysts were perfectly typical, but the connective tissue between the cysts was invaded by sarcoma tissue with round cells, which in many places had penetrated into the cyst walls and were growing in the cysts themselves. This is a unique case, and there are no others like it in literature.

If it is not deemed best to do a nephrectomy, an operation of great relief is that proposed by Curtis and Kammerer.[154] This operation consists of incision in the lumbar region, evacuation of the contents of the large cysts, and suture of the cysts' walls to the deep fascia of the lumbar region. Harrison compares this operation to iridectomy for glaucoma. It is indicated when there is pain, and also when there are pressure

symptoms. Occasionally it may prove beneficial by anchoring a movable polycystic kidney, thus preventing dragging on the pedicle. Lund[155] reports the case of a woman who was operated upon in this way, who had permanent fixation of the kidney several months after the operation, in spite of a fall a little while after the operation was done. The operation may likewise prolong life in case of sudden anuria, by relieving pressure on the renal parenchyma unaffected by the disease.

SEROUS CYSTS OF THE KIDNEY.

Simple cysts of the kidney are exceedingly rare. Their relation to polycystic disease is not altogether clear, and there is some ground for thinking that the two affections may have a similar origin. Simple cysts, however, are almost invariably unilocular, and their removal is almost never followed by recurrence. The affection is benign, and but one kidney is attacked; in this respect simple serous cysts differ radically from polycystic disease.

Etiology.—The affection generally attacks persons in middle or advanced life, and is particularly common among women.

Pathology.—Simple serous cysts must be distinguished from the small cysts which are frequently found in chronic interstitial nephritis. The cysts in sclerosed kidneys are plainly due to obstruction of the urinary tubules in consequence of inflammatory processes, and this obstruction leads to dilatation of the part above from the pressure caused by the accumulated urine. Large serous cysts occurring in chronic interstitial nephritis resemble the simple serous cysts to a marked degree, and it is only when there are associated interstitial changes that it is possible to differentiate them. In the autopsy records of the Boston City Hospital there are two cases (Autopsy Records, Nos. 96.174 and 96.82) in which there were large cysts in kidneys affected by arteriosclerosis; in the first case the cyst was as large as a small orange, and in the second it equalled the size of a fist.

Simple serous cysts usually project above the surface of the kidney, and at the base of the cyst there may be a thin layer of kidney tissue where stretching has taken place. At times there is a communication between the cysts and the renal pelvis. The cysts vary in size from a few centimeters to a large sac which fills the abdominal cavity. In a case reported by Morris,[156] one of these cysts, involving the lower part of the left kidney, filled the abdominal cavity, and the contents weighed sixteen pounds; it was filled with a dirty brown fluid and discolored blood clot. The shape is usually rounded, but sometimes it is more or less fusiform. The cortex is generally the seat of origin of cysts, but

sometimes they arise in the medullary portion of the kidney. It is probable that a single large cyst may in some instances be due to the coalescence of several smaller ones. Beyond the limits of the kidney the cyst wall is quite thin, and may be even transparent; on its surface are the bloodvessels, veins, and arteries, which are branches of the renal vessels. (Plate XLI.) In some instances the cyst is quite thick, and may be even semicartilaginous in places. The relations with the parenchyma of the kidney are very close. The fluid in the sac is usually colorless, quite clear, and, as a rule, urinary constituents are absent; a little albumin is occasionally found. If hemorrhage occurs the fluid assumes a bloody color, and subsequent changes may lead to the formation of thick colloid masses. The kidney tissue in the neighborhood of the cysts suffers from changes due to pressure, and there is evidence of atrophy; the kidney as a whole retains its normal character, and is not affected. These cysts have been known to rupture internally, and when this occurs the fluid penetrates the surrounding tissues and inflammation results. Nothing is known as to the mode of origin of these cysts. It is probable that they are due to retention, but from what cause is not evident. It seems probable that they are formed at the expense of preexisting cavities.

Symptoms.—The symptoms of this disease are ill-defined and obscure. Small cysts rarely give rise to any symptoms whatsoever, and they are usually autopsy findings. The functions of the kidney are rarely interfered with, even if the cyst is quite large, and the part of the kidney unaffected by the disease is usually found to be unaltered. The growth of the cysts is quite slow, and this slow growth accounts in part for the absence of symptoms, for the surrounding organs have had opportunity to accommodate themselves to the new conditions. Pain is absent in the majority of cases. Occasionally, however, it is a marked symptom, as in Récamier's[157] case, in a female, aged fifty-nine years, in which the tumor, growing from the superior pole of the kidney, gave rise to an attack of excruciating pain in the lumbar region, accompanied by intense vesical tenesmus, with a desire to urinate. An immediate operation was necessitated, and a cyst containing 200 c.c. of clear fluid was removed, and the symptoms subsided. Récamier explains the pain in this case as due to the crowding down of the kidney, and he is of the opinion that if the cyst had been in the lower pole of the kidney there would be no pain. It is rarely that pain as severe as this is experienced, and the discomfort is rather a dull ache and a sensation of weight, which is increased after exertion.

Tumor is seldom seen in the beginning, and it is frequently an accidental discovery. It forms a mass, easily appreciated, in the lumbar region, which may fluctuate, and gives a dull note on percussion. The

PLATE XLI.

SOLITARY CYST OF THE LOWER END OF THE KIDNEY.

(By courtesy of [illegible] Blake.)

kidney and the tumor may be movable together, and if this is so, the mistake may be made of diagnosticating hydronephrosis in a movable kidney.

Unusual symptoms, such as dyspnœa, œdema of the lower limbs, hematuria, and frequent micturition may sometimes occur, but they are very rare.

The urine usually remains unaltered throughout the course of the disease. In some cases there are attacks of hematuria, but this is a rare symptom.

If the tumor begins to grow and becomes very large, symptoms referable to pressure and weight assume prominence. These symptoms are the usual ones seen in large growths in the abdominal cavity; they are nausea and vomiting, general weakness, prostration, cardiac symptoms, debility, emaciation, dyspnœa, œdema, etc. A serious complication which sometimes happens is suppuration of the cyst cavity. In such cases the systemic disturbances are severe.

Diagnosis.—The diagnosis of simple serous cysts of the kidney is rarely made before operation. Small cysts readily escape observation, and if they are found by accident they are easily mistaken, in the absence of symptoms, for other symptomless growths in the abdominal cavity. When fluctuation is present, hydronephrosis may be difficult to differentiate; here, however, ureteral catheterization will, in the case of hydronephrosis, obtain a urine which is more or less altered from the normal. The location of the tumor in the lumbar region is suggestive of renal growth. When the tumor is of large size the disease most frequently mistaken is ovarian cystoma. Tuffier,[158] in a list of 38 cases, records that the tumor was taken for ovarian cystoma in 12 instances.

Treatment.—In the early stages of the disease before the tumor has reached a large size, curative operations are comparatively simple and beneficial, but if the tumor has been allowed to grow there are grave dangers attending operations for removal.

The condition of the patient may preclude a serious operation which involves dissection of the cyst wall, and in these cases it is best to incise the cyst extraperitoneally through a lumbar incision, evacuate the contents, and sew the edges of the incised cyst to the deep layer of the lumbar fascia. The objection to this operation is that, although the urgent symptoms are immediately relieved, there is danger that a permanent fistula may result. Tuffier,[159] in his careful study of this disease, records 3 cases out of 6 in which an intractable fistula resulted from this operation. A modification of this operation is to cut away as much of the cyst wall as possible, destroy the surface of the cyst with some caustic, such as carbolic acid, and suture the shortened edges of the part remaining to the deep layers of the lumbar fascia. Drainage is, of course, necessary.

Nephrectomy should be avoided if possible. Every effort should be made to save the remaining part of the kidney unaffected by the disease, because it is normal tissue. Besides this, the dangers of the operation are greatly increased by removal of the kidney. The opposite kidney has, presumably, not become hypertrophied, and it may not be able to assume the burden of the extra amount of work suddenly thrown upon it. Tuffier[159] records 11 deaths, or 45 per cent., in 24 cases in which nephrectomy was done. These cases include many in which operation had been performed many years before. Within the past ten years the technique has been so much improved that the mortality is not so great. Thus Albarran and Imbert[160] record 7 cases without a death, in which operation was performed within the past ten years. Nephrectomy may be required in some cases, however, particularly in those in which the bloodvessels of the kidney are intimately related with those lining the cyst wall; in such cases it may be very difficult, if not impossible, to dissect the cyst wall from this part of the kidney, and it may be safer to do a nephrectomy if the general condition of the patient permits. If most of the kidney has been destroyed, it is best to remove it with the cyst.

The operation of election is incision, evacuation of the cyst contents, and careful subperitoneal dissection of the entire cyst wall down to the kidney; when the kidney is reached the dissection of the cyst wall should be carried on so as to separate it entirely from the renal parenchyma; it will not peel out as many forms of tumor do, but must be dissected out; the raw kidney surfaces are then joined together by means of sutures and the abdomen closed. This operation was first proposed by Tuffier,[161] who first carried it out to a successful issue. There is little danger of hemorrhage by using this method, for even if bleeding is at first severe on the part of the kidney it will soon cease on applying a little pressure. The chief difficulty is the separation of the cyst wall from the peritoneum. The method is applicable for both large and small cysts, especially the latter. The small ones may be removed through a lumbar incision, but large ones will have to be attacked through an abdominal incision.

Partial nephrectomies are relatively favorable. Albarran and Imbert[160] record 5 cases in which recovery took place. Resection of the wall of the cyst, with suture of its edges to the lumbar incision, is also a relatively simple operation and is not serious.

The disease is benign in its nature, and if the cyst is removed early the patient will probably recover without further complications. It is only when the cyst is of large size that the patient's life is in danger.

PERIRENAL TUMORS.

Etiology.—These tumors are of rare occurrence. Gurlt (quoted by Rolleston and Turner[162]), in an analysis comprising 14,630 tumors examined at Vienna, of which 894 were sarcomata, found only one sarcoma of the retroperitoneal space. Hartmann and Lecène,[163] in a list of 33 cases, found tumor sixteen times on the right side and eleven times on the left; only once was it bilateral. Rambaud,[164] in an analysis of 102 cases, found 69 women and 33 men; in these cases the disease occurred most frequently between the ages of thirty and sixty years. Adami,[165] in an analysis of 41 lipomata affecting the retroperitoneal space, found the complaint more common in females than in males in the proportion of 25 to 16.

The disease is of extreme rarity in children. Neumann[166] has recorded a case in a boy, three years old, who had a lipoma of the retroperitoneal space, weighing seven pounds, which was removed by operation. The child had an enlarged abdomen since the age of thirteen months, and was thought to be suffering from tuberculous peritonitis. Recovery followed the operation and the health was good five months later.

Pathology.—Perirenal tumors are found under the peritoneum in the region of the kidney and ureter, in close relation to these structures.

The tumors are solid and cystic. The solid tumors are lipoma, fibroma, sarcoma, and mixed tumors. The first three are frequently found combined with other elements, and the resulting tumor may be myxolipoma, fibromyxolipoma, fibromyxoma, fibrosarcoma, myxosarcoma, lymphosarcoma, etc. The mixed tumors are rare. They are analogous to the mixed tumors of the kidney and may contain muscle fiber and bone.

These cysts are found: (1) cysts developing from fœtal remains of the Wolffian body; (2) serous cysts; (3) hydatid cysts; (4) blood cysts; (5) cysts of peritoneal origin.

The comparative frequency with which solid tumors occur is shown by the following figures from Hartmann and Lecène:[167] In 33 cases there were 6 lipomata, 4 fibrolipomata, 9 fibromyxolipomata, 2 fibromata, 3 fibromyomata, 5 fibrosarcomata, 2 angiosarcomata, and 2 mixed tumors.

The solid tumors of the perirenal tissue arise from the capsule of the kidney, or from the tissue underneath the peritoneum. The growth sometimes arises in the mesentery. When it arises in the mesocolon it may extend to the region of the kidney, and it is then impossible to tell what its point of origin was. The origin of sarcoma in at least two-

thirds of the cases is in the capsule of the kidney. The latter organ is more or less embedded in the growth, and it may be flattened or displaced. Infiltration of the kidney rarely occurs, except in the case of sarcoma. Adhesions to surrounding organs depend in a measure on the kind of growth. Sarcoma is very apt to have adhesions. Secondary changes are common in perirenal tumor, and chief among these is necrosis, which may occur in the centre of the growth. As a result, softening occurs, and there may result a large cyst filled with purulent fluid.

These growths sometimes reach a large size. The largest on record is that reported by Waldeyer,[168] a myxoliposarcoma, weighing sixty-three pounds. It is not unusual for these growths to attain a weight of twenty, thirty, or even forty pounds. The lipomata are particularly apt to reach a large size.

The relation of the tumor to the large intestine is of considerable importance. The ascending or descending colon is usually pushed in a forward direction, and if the tumor presents more to the inner side of the colon, this relation is important in operating.

Lipoma does not differ in histological structure from lipoma elsewhere. This tumor is very apt to be lobulated. Sarcoma is found in a number of different forms—the round cell, the giant cell, the spindle cell, etc. The tumor is very vascular, and on this account, as well as on account of adhesions, operation for removal is attended with considerable danger. Fibroma is seldom found in the pure form. These tumors are also quite vascular.

Cysts of the perirenal tissue are of extremely rare occurrence. Morris,[169] in a series of 2610 autopsies at the Middlesex Hospital, during a period of ten years, found only a single case. One side alone is affected, and the cyst is almost always unilocular. A single instance of multilocular cyst has been recorded by Albarran;[170] this was in a child ten months old, affected with a polycystic tumor of the perirenal tissue; the growth weighed a little more than a pound.

Cysts of the perirenal tissue may sometimes reach an enormous size, and they may contain many quarts of liquid. The fluid is albuminous, clear, very watery, sometimes colorless, and occasionally yellowish. Uric acid and urea have been found in these cysts. The wall is quite thin, as a rule, and occasionally ruptures, discharging the contents into the peritoneal cavity. Adhesions of the cyst wall to surrounding structures are almost never seen, and this makes removal quite easy.

Symptoms.—The chief characteristic of all growths of the perirenal tissue, with the exception of sarcoma, is their slow development. The general health suffers very little, except toward the end; during the

latter part of the trouble there is marked emaciation and loss of bodily strength. The duration of the disease from the beginning to the end is usually two or three years in the case of the more benign growths, but in the case of sarcoma it is much shorter, eight months being the average duration. As the disease progresses and causes pressure, symptoms referable to the various organs pressed upon assume prominence. The chief symptom is dyspnœa, and this constitutes the real and principal cause of suffering. Pain is occasionally the first symptom, and usually it is of a dragging, heavy character. As a rule, digestion is not interfered with, except toward the end of the disease. Œdema is sometimes seen, and is due to pressure on the bloodvessels. Among other symptoms may be mentioned varicocele, creeping and burning sensations of the skin of the abdomen, subumbilical colic, pain in the back, and various nervous phenomena. The function of the kidney is not usually interfered with, and the urine is normal. At times, however, there is an associated nephritis.

Cystic disease presents in the main the same symptoms as that of other tumors, but the evolution takes longer and may extend over a period of several years.

In sarcoma, the early manifestations are apt to be more severe and are usually of a functional character, the digestive tract being especially affected. Later in the course of the trouble, pain assumes prominence, and, if the kidney has been attacked, there may be hematuria.

On examination the tumor will be found in the lumbar region, and its consistency varies according to the nature of the growth. The lipomata are quite soft and fluctuation is not unusual. The same is true of cysts. Dulness will be made out in the flank, and this extends upward to the spinal column. If the colon does not run across the growth, dulness will be discovered all over it, and in these cases there is great difficulty in differentiating from ovarian tumor.

Diagnosis.—It is extremely difficult to make a correct diagnosis of these tumors. The points indicating the disease are: slow, usually painless, growth with absence of urinary symptoms, the growth sometimes developing to a tumor of large size, and filling the abdominal cavity. Occasionally a history may be obtained of tumor beginning in the lumbar region. A differential diagnosis between the cystic and some of the solid forms is very hard to make. The lipomata frequently give a sense of fluctuation, and other forms of growth which have become softened in the interior will likewise present this sign. The only feature characteristic of cystic disease is its usually longer course and rather milder symptoms. It is quite impossible to differentiate between cysts of the adrenal and cysts of the perirenal tissue. Sarcoma has a much more

rapid course than the other growths, and the pain begins much earlier.

The diseases most frequently confounded are: ovarian tumor, renal and suprarenal tumor, ascites, tumor of the liver, mesenteric tumor, pancreatic cyst, and hydronephrosis.

The most frequent source of error is in mistaking the enlargement for an ovarian tumor. In these cases the early history is of considerable importance. A tumor beginning in the lower part of the abdomen points to ovarian cyst, except in those cases in which perirenal tumor had a source of origin low down. In ovarian disease the tumor is apt to be limited circularly by a zone of tympany.

Hydronephrosis, in the majority of instances, has a characteristic history of crises of pain, and the intermittent character of the enlargement is also significant. Pancreatic cysts are tense and hard, usually lie behind the stomach, and, as a rule, they are small in size; the large ones are usually impossible to distinguish.

Treatment.—Operation is demanded for the removal of these growths, and the earlier the operation is done the better it is for the patient. The usually painless character of the trouble is a temptation to delay operation until the disease is far along.

The chief danger during operation is from hemorrhage. The vascular supply is sometimes very considerable, especially in the malignant forms, and there is grave danger of sudden death from hemorrhage on the operating table.

In operating upon large growths, such as lipomata, the abdominal route must be selected. A point of importance in operating is that the incision into the peritoneum covering the growth must, if possible, be made outside the colon. If made to the inside of the gut, such an incision will cut off the blood supply of the bowel and the corresponding portion of the bowel becomes gangrenous in consequence. If it should be impossible to make the outside incision, that portion of the bowel which has been deprived of its blood supply must be resected. If the tumor is a large one and has extended over to the other side of the body in the region of the insertion of the renal vessels in the large trunks, and has involved the opposite perirenal tissue, a second incision on the opposite side of the body should be made.

Operation for cysts is usually easy. The cyst wall can generally be removed entire, on account of the usual absence of adhesions. If, however, there is difficulty, the opening into the cystic cavity may be stitched to the abdominal wound and it may be allowed to drain.

The operative results in the case of perirenal tumor depend upon the size of the growth, the length of time the disease has been in existence,

and the presence of complicating elements. Adhesions greatly increase the operative risk. Malignant disease is the most serious, both on account of the constitutional effect upon the patient and also because adhesions in this disease are usually quite extensive. An incomplete operation is very fatal. If the kidney has to be removed, this will also increase the operative risk. Albarran and Imbert,[171] in a list of 45 cases, record 27 cures, 12 deaths, and 5 in which the result was unknown; cysts were not included in this list. Adami,[172] in a list of 26 operative cases of lipoma, records 12, or 46 per cent., recoveries. If the growth is of a benign character, the prognosis is usually good. Recurrence, however, may be seen in the case of lipoma. Waldeyer and Freund[173] and Adami[174] record cases in which myxolipoma degenerated into sarcoma. Tillman's[175] case of lipomyxofibroma recurred a year after operation. It was supposed that in this case the recurrence was a sarcoma. In the case of sarcoma, of course, the prognosis is very bad.

ADRENAL TUMORS.

Etiology.—Williams,[176] in a series of 8378 consecutive cases of malignant tumors in various parts of the body, found only 1 case of malignant tumor of the suprarenal gland. He collected 36 cases of adrenal tumor, and in more than one-third of them the subject was a child. In Ramsay's[177] list of 67 malignant adrenal tumors there were found 36 in the male, 26 in the female, and in 5 the sex was not given.

Pathology.—Adrenal tumors are benign and malignant.

Brüchanow[178] gives a list, covering a period of fifteen years, of 33 cases of adrenal tumor taken from Chiari's laboratory. Twenty-five of these tumors were of that form now usually described as benign hypernephroma of the adrenal, sometimes called "adenoma," occasionally "struma," and sometimes "hyperplasia."

Benign Tumors.—These growths are extremely rare, and are usually pathological findings. The following have been found in the adrenal: angioma, glioma, neuroma, gangliofibroneuroma, gangliofibromyoma, lymphangioma, lipoma, cysts, and hypernephroma.

Payne's[179] case of angioma of the adrenal is unique. In each adrenal there was a solid tumor the size of a walnut, bright red in color, which under the microscope was found to be composed of coagulated blood, inclosed in a system of anastomosing sinuses. Similar tumors were found in the liver and spleen.

Virchow's[180] case of glioma is the first mentioned of its kind. The tumor was the size of a cherry. Küster[181] also described two tumors

whose characteristics were abundance of round nuclei, absence of protoplasm, which was substituted by a network of fine fibrillæ, and inclination of the nuclei to form rosettes; this gave the impression that the tumor was made up of collections of rosettes. The whole had a strong resemblance to gliar tissue, and Küster made the probable diagnosis of glioma.

Dagonet[182] described a tumor the size of a large white kidney, which was made up of connective tissue and smooth muscle fiber, with additional groups of gangliar cells. He called it a gangliofibromyoma.

Weichselbaum[183] described a tumor the size of a cherry, which, under the microscope, was found to be made up of numerous interlacing bundles of fibers, which appeared to be non-medullated nerve fibers, having spindle-formed nuclei; there was also a peculiar large cell which, on examination, resembled a gangliar cell; these cells were arranged either singly or in groups. He considered the tumor to be a ganglioneuroma.

Brüchanow[178] describes a gangliofibroneuroma found in the left adrenal of a female sixty-eight years of age. The tumor was 1 cm. in diameter, and was sharply marked off from the surrounding tissue. Microscopically the tumor was composed of bundles of fibers having a wavy arrangement running in different directions and across each other. The growth consisted partly of connective tissue and partly of medullated nerve fiber. Here and there were thin nerve fibers in a hyaline sheath; there were also peculiar large cells which resembled ganglion cells. They lay sometimes singly, but for the most part in groups; some were round and some were elliptical; some were apolar, and others had one, two, or more processes. All the specific elements of the nervous system were contained in this tumor.

Brüchanow's[184] case of lipoma of the adrenal is unique. This tumor was an autopsy finding in a female, aged sixty-seven years. It projected above the cortex as a sharply circumscribed disk, 20 mm. in breadth. It was composed of fat tissue.

The cysts of the adrenal are of five kinds: the parasitic, the true glandular cysts, the cysts found in hypernephroma, the cysts arising from lymphangioma, and the pseudocysts.

True glandular cysts are of extreme rarity, and are unimportant, as they are of small size, and give no symptoms; they occasionally take origin from embryonic remains.

The cysts sometimes found in hypernephroma are comparable to the cysts occasionally seen in "struma" of the thyroid, and in these cases are of small size and unimportant. Henschen[185] believes, however, that these cystic dilatations in the case of hypernephroma may reach a large size.

The cysts arising from lymphangioma are the result of lymphangiec-

tasis, and may attain to a very large size. This form is the one usually found in the adrenals. In this variety the cyst wall is thick and sometimes contains muscular fibers; the cavity is lined with flattened endothelium. These cysts may be either unilocular or multilocular. The contents are either a dark or a light fluid of watery consistence.

The pseudocysts result from tuberculous softening, or they are collections of blood.

Cystic disease of the adrenal is of great rarity, and Terrier and Lecène[186] have recorded the only ten instances in literature.

Benign hypernephroma will be discussed with the malignant tumors.

Malignant Tumors.—As in the case of the kidney, the question of malignant tumors of the adrenal is far from settled. There exists great confusion with regard to these tumors, a confusion which has been made needlessly great by the desire and attempt of many writers to explain what is as yet incapable of solution. In the published pathological reports there exists no uniformity of opinion as to the nature of the growths under discussion. Lists of cases of "carcinoma" of the adrenal are met with which exactly resemble, with reference to the histological structure of the tumor, other lists of "sarcoma" and of "adenoma" and of "malignant struma," compiled by other writers of equally good repute. In the presence of such confusion, statistics bearing on the relative frequency of the variously described malignant tumors can have no value.

Hektoen,[187] in his introduction to this class of tumors, presents the case in a very judicious way. He says: "The nomenclature of these tumors presents certain difficulties, because in their morphology and in the arrangement of the cells and the stroma they resemble adenomata and carcinomata, and are frequently described as such. The more diffuse hyperplasias of this kind were long ago designated as 'struma suprarenalis' by Virchow. In view of their peculiarities, these tumors are given more general non-specific names, such as 'adrenal tumors' (*sensu strictu*) or hypernephroma."

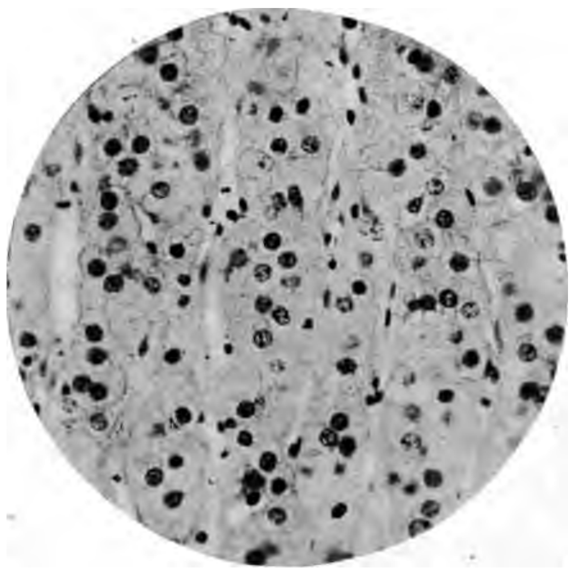
The chief characteristics of a malignant growth of the adrenal are the following:

The tumor is either single or multiple; when multiple, the growth is composed of nodules of different size, each surrounded by a capsule which limits it from the surrounding adrenal tissue. The large tumors may reach a good size, even to that of one or two fists, or much larger. Metastasis is mainly through the circulatory system; the organs chiefly attacked are the lungs, liver, and bones. It is to be remarked that the organs attacked secondarily are those chiefly attacked by metastasis in hypernephroma of the kidney. The metastases resemble the parent tumor and bear a striking resemblance to hypernephroma of the kidney.

These peculiarities are strong proof that hypernephroma of the renal parenchyma is derived from adrenal "rests" in the kidney.

Under the microscope malignant tumor of the adrenal resembles markedly the cortex of the normal adrenal body, both in the form and arrangement of the cells. In some places the arrangement suggests that of the zona reticularis; in others, that of the zona fasciculata. Thin-walled capillaries surround the groups of cells, which are arranged in columns or rows two or three deep, in alveolar form, and connective tissue septa from the capsule of the tumor penetrate the growth and divide it into separate parts. The cells, in rows, are placed directly on the capil-

FIG. 395



Benign hypernephroma of the adrenal, showing the arrangement of the cells, two or three rows deep, in close apposition to the thin-walled capillaries, which form the stroma of the tumor. × 250. (Classified as "benign adrenal adenoma" at the Boston City Hospital Pathological Laboratory, No. 98,55.)

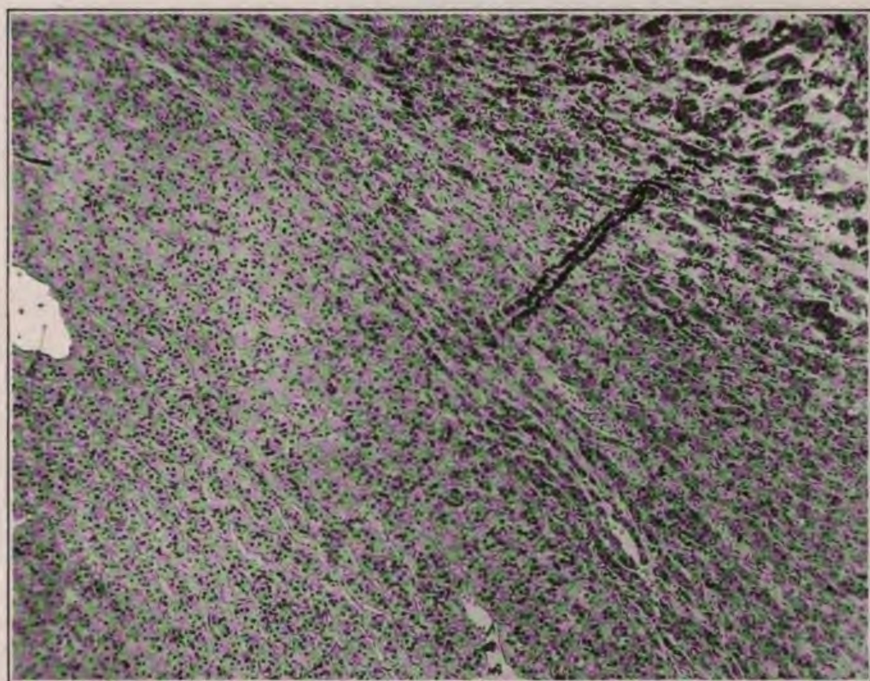
lary vessels, as in hypernephroma of the kidney; the first row is placed tolerably perpendicularly on the walls, and the others rather irregularly; they have large nuclei, are polygonal in shape, and contain vacuoles which correspond to areas which formerly contained fat which has been extricated in the process of mounting. The shape of the capillary interspaces between the tumor cells is often quite irregular. Evidences of hemorrhage and necrosis are seen in places.

Benign forms of adrenal tumor (other than those previously described) *resemble the malignant tumor to a marked degree.* They may remain latent in the adrenal for a long time, and may give no evidence of their

presence. Most of the benign growths do not exceed the size of a pea or a walnut. They may be single or multiple.

Under the microscope the benign growths also show pictures recalling to a marked degree the adrenal cortex in shape and arrangement of the cells (Figs. 395 and 396). So closely do these tumors resemble the cortex that the term "hyperplasia of the adrenal" has frequently been given to the growth. As in the malignant tumor, the groups of cells are arranged in columns or rows in alveolar form, and the cells rest on thin-

Fig. 396



Benign tumor of the adrenal (hypernephroma), showing the tumor, the capsule, and the zona fasciculata. × 62. (Classified as "benign adrenal adenoma" at the Boston City Hospital Pathological Laboratory, No. 98,55.)

walled capillaries which form part of the stroma of the tumor. The cells are polygonal, have large nuclei, but they are smaller than is the case in the malignant growths; and another marked difference is that in the benign form the rows of cells are arranged much more regularly and the capillary interspaces are narrower.

The similarity in structure between the apparently benign forms of adrenal tumor and the malignant suggests a close relation between the two. There are many who assert that the benign go on into the malig-

nant. This has its analogy in hypernephroma of the kidney and in other kinds of tumors in other parts of the body.

A study of the histological characters of the tumors of the adrenal, benign and malignant, given in the literature of the subject, discloses the fact that they all resemble either one or the other of the two forms just described. These tumors have been variously named. The benign forms have been called "struma of the adrenal," "hyperplasia of the adrenal," "benign adenoma of the adrenal," etc., while to the malignant forms have been given the names "carcinoma," "malignant struma," "sarcoma," etc.

All the tumors designated "sarcoma," found in the literature, reveal practically the same features, namely: arrangement of the cells in columns or rows in a manner suggesting the zona fasciculata of the normal adrenal; capillaries surrounding the groups of cells arranged in alveolar form. The same is true of the tumors designated "adenomata" and "carcinomata." It is thus evident that there is a great deal of confusion in regard to these growths.

Various views are held by different observers in regard to the nature of adrenal tumors.

Ribbert[188] calls these tumors adenomata, and states that there is a benign and a malignant form, with transition forms in between. He calls attention to the fact that the structure of both benign and malignant forms is essentially the same, but he denies the existence of definite alveoli marked off by septa, and describes the appearance as "columnar cell masses arranged in the network of bloodvessels. Within some of the masses was a lumen due to central necrosis, and not to be considered true glandular formation." He thinks that the diagnosis of these adrenal tumors can be easily made from the character of the structure of the youngest portion of the growth.

Letulle[189] has given to these growths the name "nodular hyperplasia" of the suprarenal capsule. He considers the growth in the beginning to be a simple hyperplasia of the middle zone of the cortical substance, and more rarely a hyperplasia of the glomerular zone. He thinks that by insensible transitions large nodules of hyperplasia may pass to "adenomatous" or "benign epitheliomatous" forms, and he believes that he has been able to detect hyperplasia as well as adenomatous formation in the same specimen.

Virchow[190] was the first to call attention to this form of growth, and he gave it the name "struma suprarenalis." He compared it to thyroid hyperplasia, and called attention to the marked similarity which exists between the two tumors. "A characteristic of the growth is the condition of hyperplasia of the fascicular portion of the adrenal."

Borst[191] speaks of a diffuse swelling which corresponds to a general hypertrophy or hyperplasia; and also of circumscribed larger and smaller tumors occurring as soft, yellowish enlargements in the cortical or medullary substance of the organ, which consist of typical suprarenal structure. In both of these forms, according to Borst, there is a delicate stroma formed almost entirely of capillaries, which embrace larger masses, either in the form of pillars, or, at times, in the shape of larger polygonal roundish masses of cells situated around the capillaries. Borst thinks that from this suprarenal hyperplasia there are real or apparent transitions into tumors of considerable size, which show variations from the structure of the normal suprarenal, in that the single masses of cells not only increase in number, but also that the single cells are larger. Borst is not willing to separate this form from the group of hyperplastic tumors, and he furthermore states that he does not believe that it is a glandular growth of the character of an adenoma. Until the obscurity which surrounds it has been cleared up, he thinks that a purely indefinite name should be given to it, and that the term hypernephroma is the best under the circumstances.

It will be seen from the foregoing that there is a great deal of confusion in regard to these tumors. The numerous names given to the malignant forms show how uncertain is its pathogenesis. It has been called "carcinoma," "sarcoma," "malignant adenoma," "perithelioma," and "adenocarcinoma," by different pathologists whose ability is unquestioned. The adrenal is histogenetically derived from the mesoderm (Hertwig-Poll[192]), according to the latest views. This would class these tumors among those of a connective-tissue type. If we adopt the histogenetic classification of tumors, it may be right to consider many of these growths sarcomata. Morphologically, the tumor has marked resemblance to carcinoma or adenoma, and many insist that the tumor should be classed accordingly. Until the obscurity which surrounds these growths has been cleared up it will be well to give them the purely indifferent names, benign or malignant hypernephroma of the adrenal.

Symptomatology.—Benign forms of growth give no symptoms whatever, and these tumors are generally pathological findings.

Malignant forms of adrenal growth all present the same clinical picture.

The chief characteristic of the disease is a gradually progressing condition of bodily wasting. The patient, without any special assignable reason, appears to be running down, loses flesh and strength, becomes anemic, is indifferent, loses ambition to work, and gets into a steadily increasing condition of decline. Anorexia is a prominent symptom, and nausea and vomiting may occur. There may be constipation or diarrhœa. Sometimes there is a slight fever, but usually the temperature is

normal or subnormal. Later in the course of the disease œdema may be present, and when it occurs it is usually due to some renal change.

The presence of tumor is a marked symptom and directs attention to the seat of the trouble. In the early part of the disease, however, repeated examinations may fail to discover any tumor at all; this is because the adrenal is situated high up under the ribs and cannot be reached in case of of a moderate enlargement; later in the course of the disease, however, a tumor appears below the ribs. After the tumor has gotten well under way, pain may assume importance. The pain is felt at the seat of the growth, but it may, however, be referred to various parts of the body; for instance, the epigastrium, the knee, the ankle-joint, and the shoulder-tip.

Hematuria is of extremely rare occurrence, and usually is not dependent upon any disease of the renal substance. When it does occur, it may be due to the involvement of the renal vein by the growth, thus giving rise to a condition of passive congestion of the kidney. Ramsay[193] noted it only twice in 67 cases.

The skin changes are sometimes characteristic, but they are not of frequent occurrence. The color of the skin does not always show the typical bronzing which is seen in cases of tuberculous disease of the adrenal, but it may assume a peculiar dirty, brownish color. Ramsay[193] found definite bronzing, however, in 3 out of 37 cases; in 9 of these cases there was some change in color, such as slight brownish discoloration; in others, the skin was simply muddy looking. The parts of the skin affected by the discoloration are the face, hands, genitals, axillæ, gums, and nipples. The reason why Addison's disease produces more characteristic skin changes than are seen in malignant trouble may be explained in part by the very destructive nature of the tuberculous process, by which the cells are completely destroyed. In malignant disease the case is different. In the first place, the tumors are often unilateral; and in the second place, the cells of the new-growth do not interfere seriously with the function of the organ. This is a feature of malignant disease, and finds its analogy in cases of carcinoma of the liver, the metastases of which sometimes secrete bile.

In some cases of malignant disease of the adrenal the symptoms are not referred to this organ. Ramsay calls attention to this fact, and he found this to be the case in 13 out of his 67 cases. In 5 of these the symptoms were confined to the respiratory tract; among the remaining 8, one patient died from sudden œdema of the glottis, while the others died from gradual decline without any recognizable symptoms whatever.

Toward the end of the disease emaciation is extreme; there is a condition of profound cachexia, and the end may be by convulsion or

coma. Uncontrollable diarrhœa has sometimes contributed to a fatal termination.

The symptomatology of malignant disease of the adrenal in children is in the main very similar to that in the adult. There is the same bodily wasting and the same mental apathy. The latter may be a marked feature before local symptoms have manifested themselves; the child is noticeably dull, and does not develop in the normal way; the speech may be thick, and the child not talk plainly. Anemia comes on early and is a marked symptom. As the disease progresses, skin changes may occur, but these changes are not a marked feature and have been reported in a few instances only. The skin may be coarse, and there may be a peculiar bloated condition of the face. The skin is never pigmented as it is in Addison's disease, but it may assume a peculiar coppery color, which is quite marked. Toward the end of the disease symptoms due to the rapidly growing tumor become prominent. The tumor is, of course, apparent, and is always a marked feature. Dyspnœa, cyanosis, pain at the site of the tumor, and in the vicinity of it, diarrhœa and colic, and sometimes, though rarely, fever, are complained of.

By far the most interesting feature of the disease in children are the changes that are produced in the body in consequence of a tumor of the adrenal gland. Chief among these is precocious puberty. This is mentioned in one-half of the reported cases. This precocity is shown by the general appearance of the patient. A child of fourteen may look like a little man of forty years of age; there is a thick growth of hair on the face, and there is also great muscular development. The hairy growth is also abundant in other parts of the body, especially in the genital region and in the axillæ. Besides these changes there may be also marked development of the genital organs, and they sometimes develop in an abnormal way. Orth[194] reports the case of a female child, aged four and one-half years, who had pubic hair during the last six months of life. The external genitals were precociously developed, and the clitoris was like a small penis. The breasts may also be overdeveloped. Besides these changes, there may also be overproduction of fat tissue. Hutchinson[195] has recorded an extraordinary case of asymmetrical hypertrophy of the body in a male child, four months old, affected with a left adrenal "hypertrophy." The child's left side was much larger than the right, especially the thigh, leg, and arm. At the autopsy a similar condition was found in the paired organs of the body, the left-sided ones being much larger than the right-sided ones.

Linser[196] believed these cases of giantism to be due to the fact that the tumor cells, in enormous numbers, have not lost entirely the function of the normal adrenal cells, which, in early life at least, are supposed to

exert some influence on the bodily growth. This seems reasonable, as it has been shown that the opposite condition, atrophy of the adrenals, is sometimes associated with dwarfism.

In 20 cases of malignant adrenal tumor in children there were 14 females, 4 males, and in 2 the sex was not stated. The usual time of appearance of the tumor is during the very early years of life. Of the 20 cases mentioned, 5 occurred during the first year of life, 3 between the first and second, 4 between the second and third, 2 between the third and fourth, 3 between the fourth and fifth. There were no cases between the sixth and eleventh years. There was 1 case each during the twelfth, thirteenth, and fourteenth years.

Symptoms due to cysts of the adrenal are obscure and ill-defined. It is almost impossible to distinguish them from pararenal cysts, and the two affections are practically clinically identical. Suggestive of adrenal cyst is a tumor of slow evolution developing in the hypochondriac region, with a tendency to press the diaphragm upward, and pointing below the costal margin. Occasionally these cysts will give rise to excessive pain, coming on in attacks like gastric crises; these pains sometimes radiate toward the sacrum and the thoracic region, and may be accompanied by vomiting.

Owing to the non-malignant character of the affection, one would not expect to see such marked symptoms of progressive wasting and decline as are seen in the case of malignant disease of the adrenal. Urinary symptoms are usually absent.

Diagnosis.—The diagnosis of adrenal growth is extremely difficult. The gradual loss of weight, anorexia, physical decline, and wasting are suggestive but not characteristic. These symptoms are indicative of a serious disease. A gradually growing tumor in the hypochondriac region, pushing the diaphragm upward, and pointing below the costal margin, has the characteristics of an adrenal tumor; but here it is difficult to distinguish such a tumor from a renal growth. Finding an area of tympany across such a growth is also of importance, because naturally, from the retroperitoneal position of the tumor, the intestine will always be found in front of it. In the absence of tumor, the metastases in other parts of the body to which the primary growth has given origin should excite the suspicion that the primary focus is elsewhere, and should lead to a continued examination of the abdominal contents. As hematuria is only a very exceptional symptom, Ramsay[193] having noted it only twice in 67 cases, its absence, in the presence of a tumor, is of diagnostic importance in differentiating renal growths, for with the latter hematuria is a fairly constant feature. One should always remember, however, that hematuria may arise from other causes than renal or adrenal disease. The ideal finding is pain, symptoms of wasting and decline, and the

presence of an unusually mobile tumor under the ribs, which is nodular in character, and at the lower end of which the smooth lower pole of the kidney may be felt, but this association is seldom found. Adrenal tumors cannot be differentiated from pararenal tumors lying medially in front of the kidney. The urinary findings in adrenal tumor are not characteristic, and in most cases are unimportant. Pigmentation of the body is strongly suggestive, but it is rarely seen. Israel[197] calls attention to the fact that pain and paresthesia arising from the encroachment of the tumor on the nerve roots distributed along the course of the lumbar plexus is important in the diagnosis of adrenal tumor, because, as a rule, these are early symptoms in the case of the adrenal, and late symptoms in the case of the renal growths; the fibrous capsule of the kidney acts as a barrier and prevents the spread of the tumor beyond the boundary of the kidney for a long time. In the case of the adrenal, however, it is different; there is no membranous capsule, and spreading to surrounding tissues is easy; hence the early pain due to involvement of nerves. Again, Israel[198] believes that renal tumors which have not developed in movable kidneys appear under the costal margin between the ninth and the eleventh ribs, while tumors of the adrenal appear more toward the median line and extend forward to the eighth or even the seventh costal cartilage; this results from the anatomical position of the gland. Tumors formed by the blending of the adrenal and kidney present the lower border as a continuous line of considerable breadth, and the boundary may be even almost horizontal.

Addison's disease rarely gives rise to a palpable tumor, and in this disease we may have tuberculosis elsewhere in the body, which is extremely suggestive of the diagnosis. The skin changes in Addison's disease are more pronounced and are more frequently met with than in adrenal growths. At the same time, Addison's disease, with marked tuberculosis elsewhere in the body, may be very difficult to differentiate.

Hepatic tumors may give rise to confusion, but careful attention and observation will sometimes clear up the diagnosis. Jaundice is especially significant, but when absent, other characteristics must be relied upon. The nodular character of the edge of the liver, the increase in the size of the organ as a whole, and the association of malignant disease of the breast or of the stomach are diagnostic points in favor of hepatic cancer.

Cysts of the adrenal are extremely rare, and they are almost impossible of diagnosis. They are always unilateral and are never the cause of bronzing of the skin. Fluctuation may be felt, but this is not a distinguishing feature of tumors in this situation, for a perirenal lipoma will also give the same sign. Other cysts found in this situation are hydatid cysts, pancreatic cysts, and cystic dilatation of the gall-bladder. Pan-

creatic cysts are tense, have an elastic feel, and their relation to the stomach, being behind the organ, serves as a differentiating feature. Cystic disease of the gall-bladder may be associated with biliary colic and jaundice from obstruction; the superficial position of the bladder is of diagnostic help. If seen early the adrenal cyst will be found presenting below the costal margin, and more to the right and more posteriorly than the gall-bladder; there will probably be resonance in front of it. Cysts of the mesentery, mesocolon, serous cysts of the spleen, and finally hydronephrosis, may be mistaken for this disease.

Treatment.—The first question which comes up in regard to treatment is the condition of the opposite kidney and adrenal. Here there is a real danger in the case of adrenal tumor if the disease has been progressing slowly. If it is confined principally to the adrenal gland, and the corresponding kidney has either not been seriously encroached upon or not at all, it will necessarily result that this kidney will continue under these circumstances to perform its functions in a normal or nearly normal way. The opposite kidney will not, therefore, undergo compensatory hypertrophy, which it would otherwise have undergone pari passu had the renal parenchyma of the diseased side been destroyed; both kidneys will, therefore, perform an equal or nearly equal amount of work. This constitutes a danger in operations for adrenal tumor. If the kidney on the diseased side is removed with the adrenal tumor, the whole work of excretion suddenly falls on the one remaining kidney, which is not as ready to assume added work as if it had undergone preliminary hypertrophy. Anuria following operation, therefore, is greatly to be feared. Morris[190] would not agree with Ramsay in always removing the kidney with the tumor. He advises partial nephrectomy in case of need, and if the kidney appears to be sound he believes it should not be touched.

There is a decided tendency toward involvement of the opposite adrenal, and its condition should be investigated by palpation through an abdominal incision before the radical operation begins.

The operation for the removal of adrenal growths is always very serious. Adhesions to surrounding organs are many, and they give rise to hemorrhage; to say nothing of the friable nature of the growth, which also constitutes a source of danger from hemorrhage. Adhesions to the diaphragm may be dense, and there is danger of perforation of the pleural or the pericardial cavity.

As the operation offers the only chance for relief, it should always be advised, especially in cases in which the disease is causing pain. Left to itself, the disease terminates in death in about ten months.

In the few cases of adrenal tumor of the malignant type in which

operation was performed, to the number of four, death followed either immediately or within a few weeks. Ramsay[200] reports a survival after three years in a female, aged fifty-three years, but a careful perusal of the histological characters of this tumor shows that the only claim it had to being a sarcoma was the presence of some spindle cells, which might well have been due to pressure. The main part of the tumor was a large cyst. There was an entire absence of structure ordinarily found in malignant adrenal tumors, and there were no metastases. The four cases mentioned are two reported by Ramsay,[177] Roberts'[201] case, and Thornton's case.[202]

The operation has been performed once only on a child, and death followed immediately (Dobbertin[203]).

Cysts of the adrenal should be removed if possible. The course to be followed must depend on the extent and firmness of the adhesions; if the cyst wall can be separated from the surrounding structures with ease and within a reasonable time, it is advisable to adopt this course; otherwise, it would be better, after emptying the contents of the cysts, to suture the opening to the abdominal incision.

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CHAPTER XXVII.

SURGERY OF THE KIDNEYS.

Surface Landmarks.—A line drawn horizontally through the body at a level with the umbilicus touches the lower end of the right kidney and passes about half an inch below that of the left one.

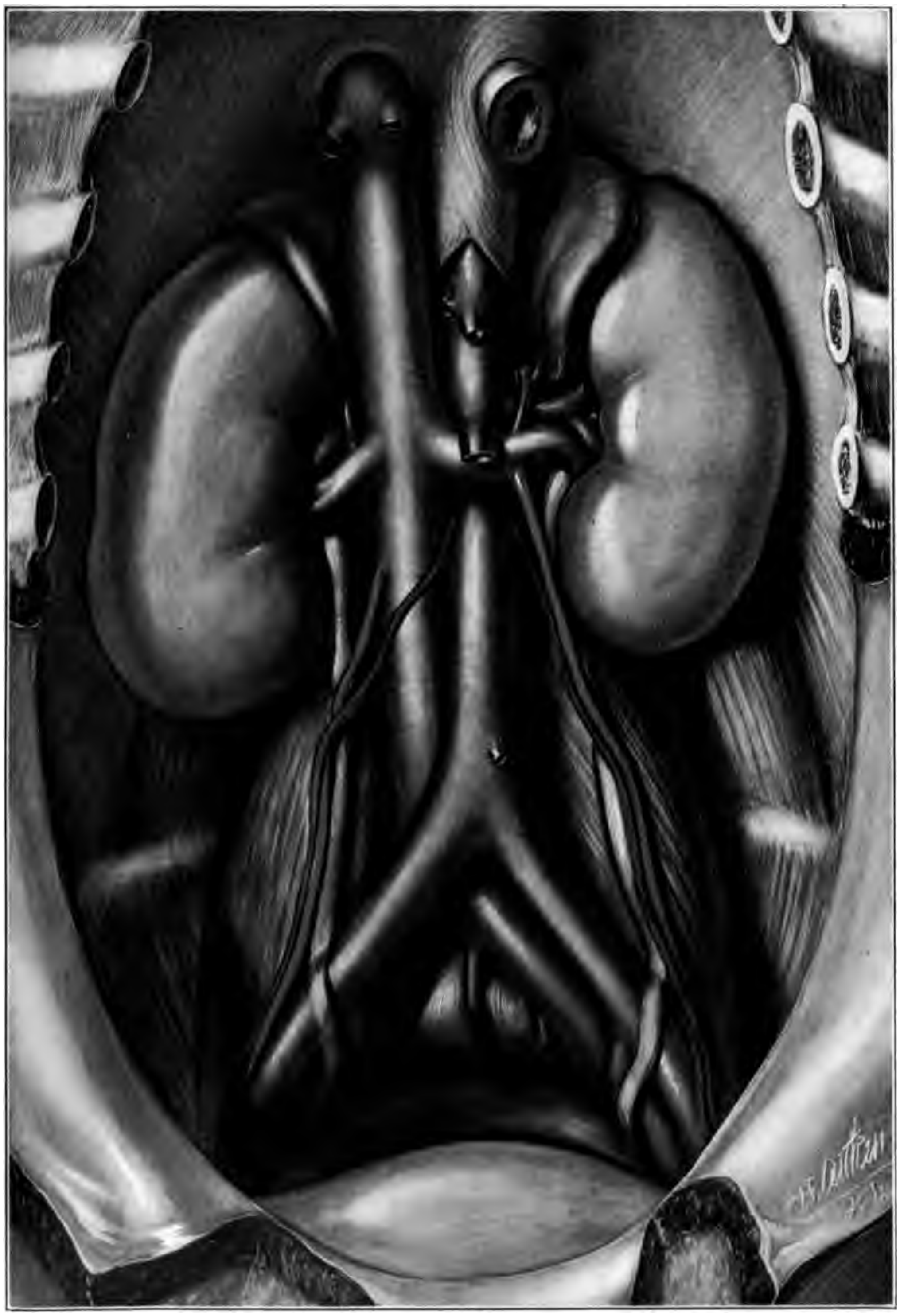
A perpendicular line drawn between the middle of Poupart's ligament and the free border of the ribs has two-thirds of the kidney to its inner side and one-third to its outer side. A diagonal line corresponding with the lower border of the twelfth rib will cross the kidney *obliquely to its long axis*, and will have about one-half of the right and about two-thirds of the left kidney above it. A line drawn from the midpoint of the last rib to the middle of the iliac crest will correspond to the outer border of the quadratus lumborum. The posterior axillary lines on each side of the body correspond roughly with the lines of the two peritoneal reflections from the lateral aspects of the abdominal walls as the peritoneum leaves them to pass to and over the ascending and descending colons, respectively.

A line parallel with and about one inch outside the linea semilunaris is that along which, on the inner surface of the abdominal wall, the peritoneum can be most readily detached from it. It is on this account that this line is chosen for the incision in the so-called "paraperitoneal nephrectomy."

Position of the Kidneys.—The following are the points of surgical importance in connection with the location of the kidneys. The kidneys are retroperitoneal organs and occupy cup-like depressions on either side of the vertebral column in the lumbar region, immediately below the diaphragm. Volkoff and Delitzen believe that the form of these fossæ is the chief element in retaining the kidneys within their normal sphere of mobility. The kidneys are not fixed organs, but normally and in correspondence with the respiratory movements of the diaphragm, make an upward and downward excursion of from one-half to three-quarters of an inch. The organs are not on the same level, the right one being usually about one-half inch lower than the left.

About one-third of the right and one-half of the left kidney are above the lower border of the twelfth ribs. The long axis of the kidney is directed diagonally to the vertical axis of the body, the upper end of the organ being inclined toward and the lower one away from the vertebral

PLATE XLII



THE POSITION OF THE KIDNEYS.

Their relations to the diaphragm, muscles of the loin, adrenal gland, the main renal bloodvessels, the ureters, and the course of the latter as they pass to the bladder.

column. The upper pole is about two inches and the lower one three inches distant from the vertebral spines. The direction of the long axis of the kidney corresponds with that of the outer border of the quadratus lumborum muscle.

Fig. 397

Surface markings showing the positions of the kidneys.

About one-half of the posterior surface of the kidney rests upon the lower and posterior part of the diaphragm, while its upper part, being in contact with the *hiatus* of the diaphragm (see Plate XLII), is brought into close proximity to the pleura, which explains the relative ease with which pus formations originating in the perirenal fat tissue make their

way into the pleural cavity, and also, in some cases, the difficulty there may be in determining whether pain proceeds from the pleura or from the kidney. The rest of the posterior surface of the kidney below the diaphragm lies upon the quadratus lumborum—the outer border of which it overlaps by about five-eighths of an inch—and upon the transversalis muscle. The inner part of the lower end touches the outer border of the psoas. (Plate XLII.)

Preparatory Measures and Those Used to Counteract Shock.—As routine measures, the following things should be done:

When nephrectomy is contemplated the essential step is to be certain of the capability of the function of the other kidney. (For the manner of testing this see chapter on Urinary Analysis.)

Other than this, the patient's general condition should be carefully studied, the cardiac and pulmonary sufficiency or the presence of disease noted and taken into account.

We advise the administration of a subcutaneous injection of sterile saline solution at the beginning or just before all serious operations, and that it be repeated in case of shock during their performance.

If the bladder is infected, urotropin, in seven and one-half grain doses, should be given thrice daily, for three days before the operation, or in one-half the amount, if it is administered for a longer time preceding it.

During the operation the patient should be kept warm with hot-water bags, and a shock enema of coffee, brandy, and hot water should be administered, if required. We do not favor the employment of the large doses of strychnine that it was customary to administer a short time ago for the purpose of combating shock.

Adrenalin to overcome the effects of hemorrhage is of value, but must be given with caution lest the contraction of the arterioles, which occurs as a result of its employment, throw too great a task upon the heart.

The shock attending the performance of lumbar nephrotomy, except there be severe hemorrhage, is slight. That seen in connection with nephrectomy may be very severe, though in the uncomplicated cases it is not very serious. Nephropexy and decapsulation are attended by very little shock.

NEPHRECTOMY.

Historical.—In 1861 the American surgeon Walcott did nephrectomy for the first time. He removed by this operation a cancerous kidney from a woman aged fifty-eight years. The operation was a transperitoneal one. The patient succumbed on the fifteenth day.

Fig. 398

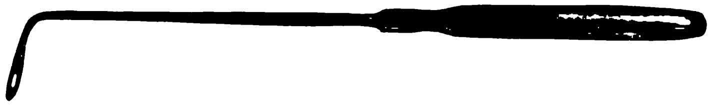


Fig. 399

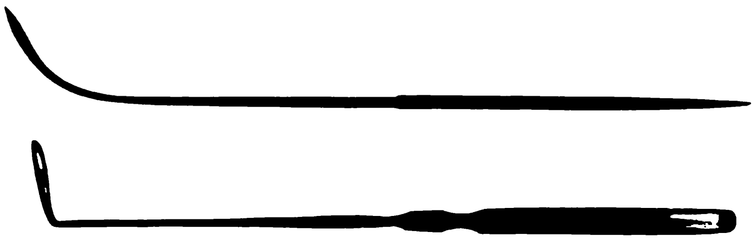


Fig. 400

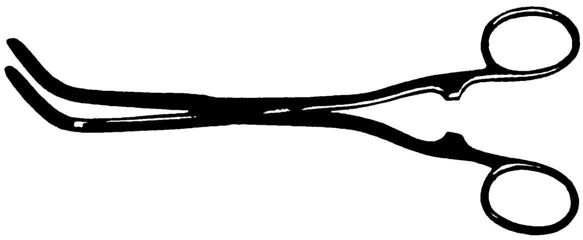


Fig. 401

Fig. 402

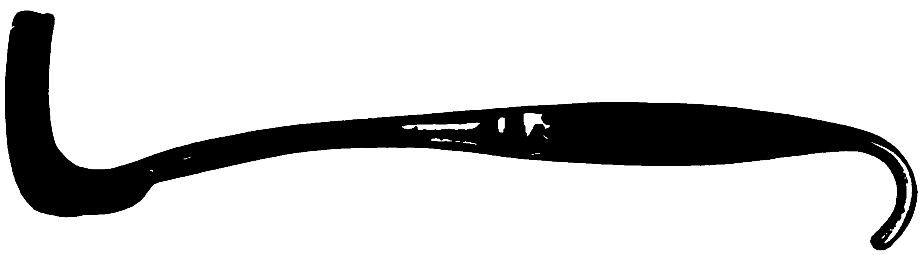
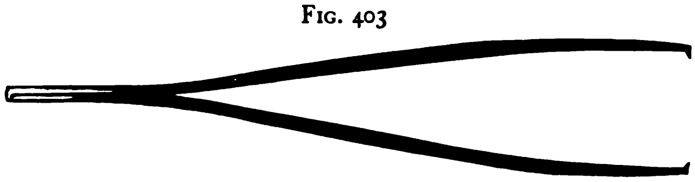


Fig. 403



Instruments for lumbar nephrectomy.

FIG. 404

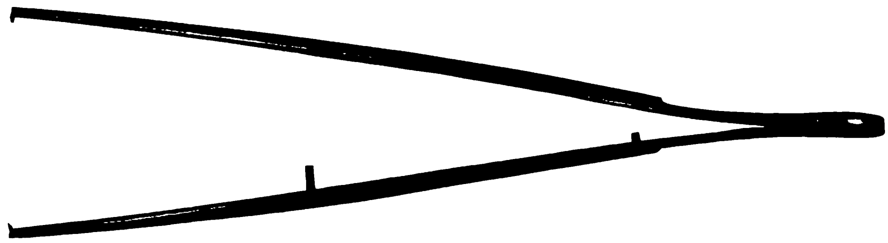


FIG. 405

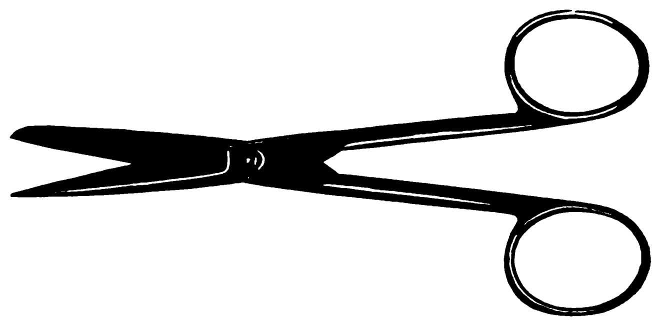


FIG. 406

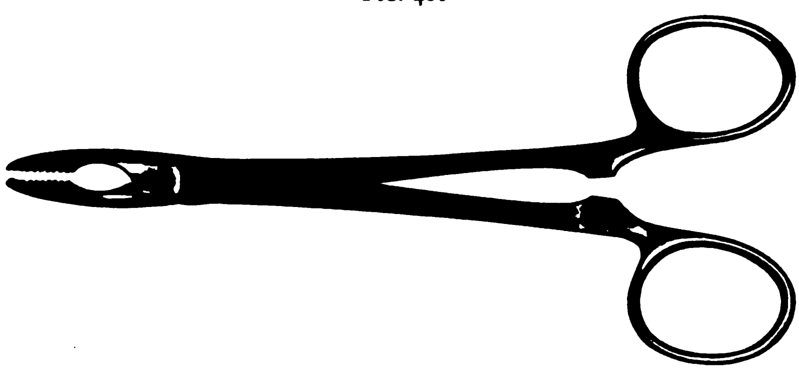
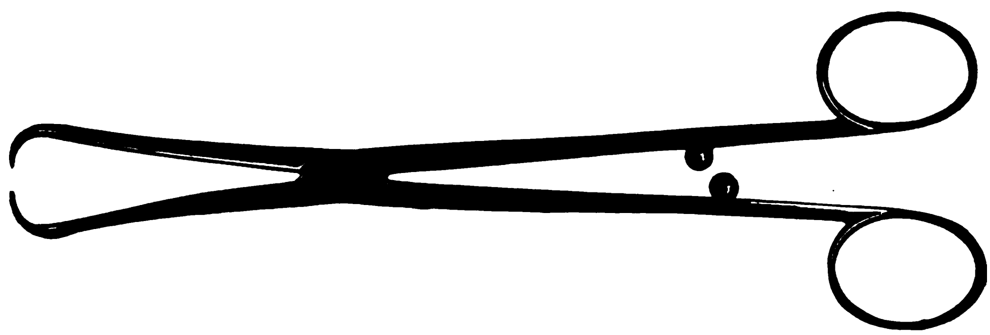


FIG. 407



Instruments for lumbar nephrectomy.

In 1868 Peaslee, also an American, did the second operation, which was likewise transperitoneal.

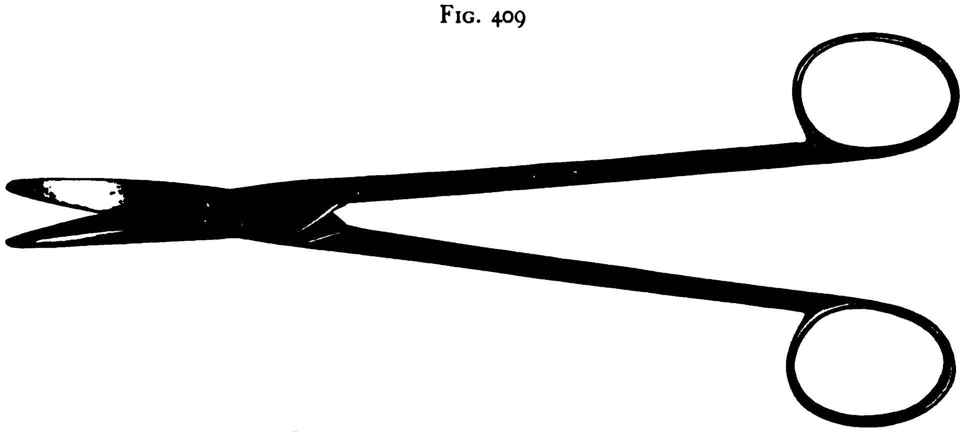
In 1869 Simon, of Heidelberg, removed a kidney for the first time by the lumbar method, approaching the organ through a vertical incision parallel with the border of the erector spinæ muscle. The operation was done for the relief of a renal fistula. The patient recovered.

In 1870 Gilmore, an American, removed a kidney from a woman who was five months pregnant. The patient recovered without having a miscarriage.

In 1871 Simon again operated by the lumbar route in a case of renal calculus. This patient died.

Fig. 408

Fig. 409



Instruments for lumbar nephrectomy.

In 1872 Durham did the first nephrectomy in England. Peters, of New York, did the operation in the same year. Both of these patients died.

In France the first operation is credited to Le Fort, in 1880. Péan did the first successful one in that country in 1884.

The first successful transperitoneal nephrectomy for cancer of the kidney was done in 1878 by Byford, of Chicago. The woman who was submitted to it had had no recurrence of the disease at the end of two years.

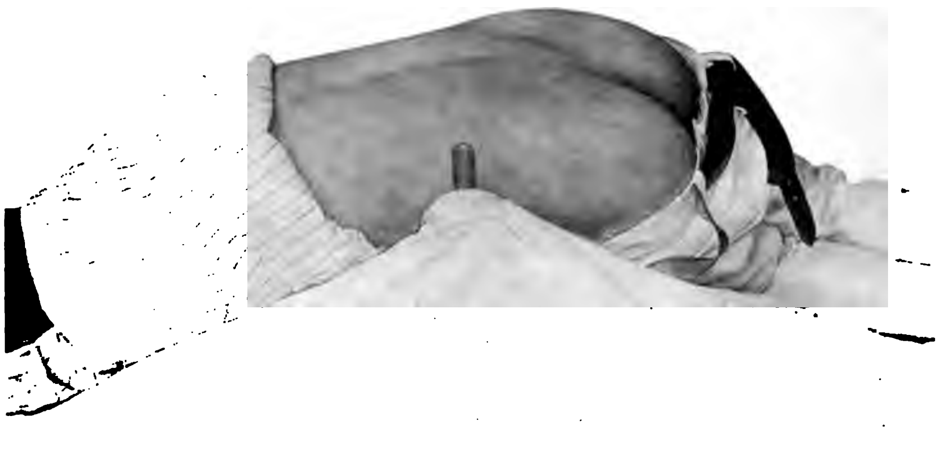
Lumbar Nephrectomy.—Instruments (Figs. 398 to 409).—Scalpels, long-handled scissors with blades curved on the flat, straight, blunt-pointed scissors, dissecting forceps, toothed forceps, two pairs of clamp

forceps with blades at a little less than right angles, trocar, right and left aneurysm needles, abdominal retractors, needle-holder, intestinal needles, curved round needles, straight glover's needles, No. 1 and No. 2 catgut ligatures, silk ligatures.

Position of the Patient.—It is essential to the ready and successful performance of the operation that the patient shall be properly placed. The following indications must be fulfilled:

1. The iliocostal space must be made as wide as possible.
2. This must be done without impeding the respiration or bringing the body across a hard and too narrow edge of a table or support of any sort.
3. The position should be maintained during the operation without the aid of an assistant to keep the patient in it.

FIG. 410



Patient placed upon the Cunningham operating table.

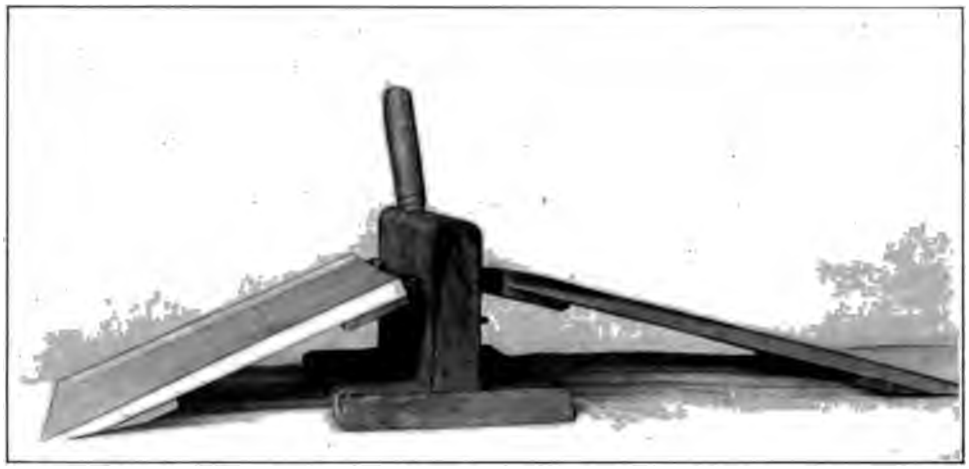
4. The mechanical contrivance used for the purpose should have a means for exerting pressure on the front of the abdomen which will push the kidney up into the lumbar wound and thus make it accessible.

These requirements, we believe, are best secured by the Cunningham operating table. It is by far the best contrivance for the purpose that we have seen, and has been of great service to us (Figs. 410, 411, and 412).

The Cunningham Operating Table.—The table is made up of three parts. Two inclined planes, one on either side of a central block, to each side of which they are attached by strong steel hooks, and from which they can be unhooked when the apparatus is packed to be carried from place to place. The central block is a heavy piece of wood with a rounded upper surface. It is set into a board upon which the further ends of the planks forming the inclined planes are also rested.

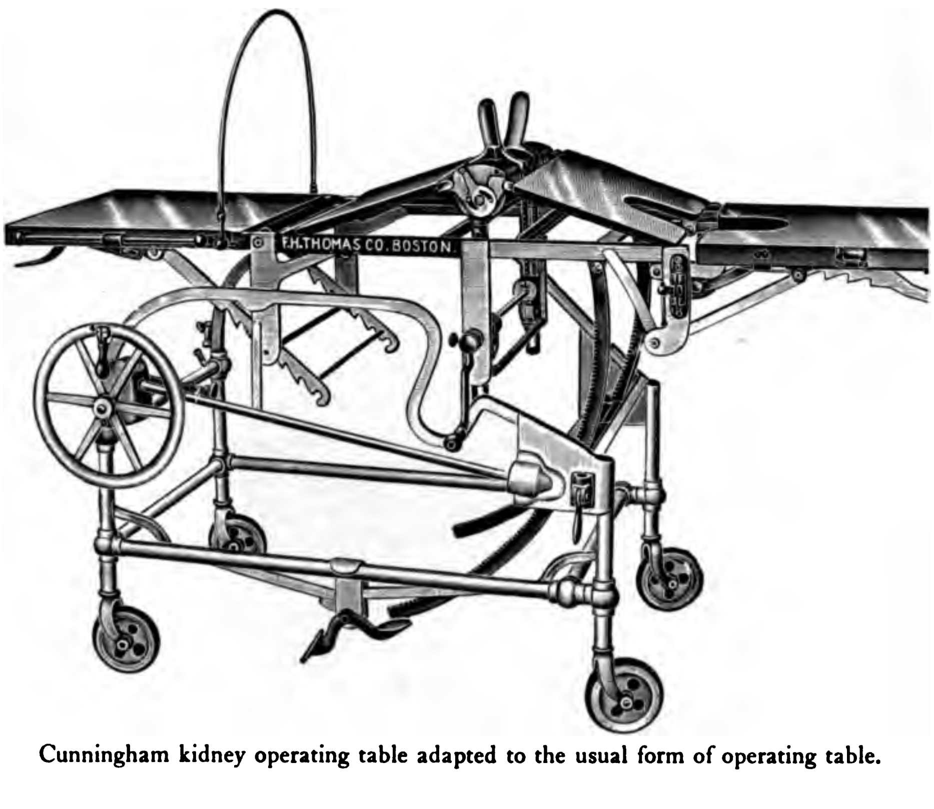
Upon the upper surface of the central block are bored four holes, two near either end of it and about three inches apart. These holes are

Fig. 411



Cunningham operating table for lumbar operations on the kidneys.

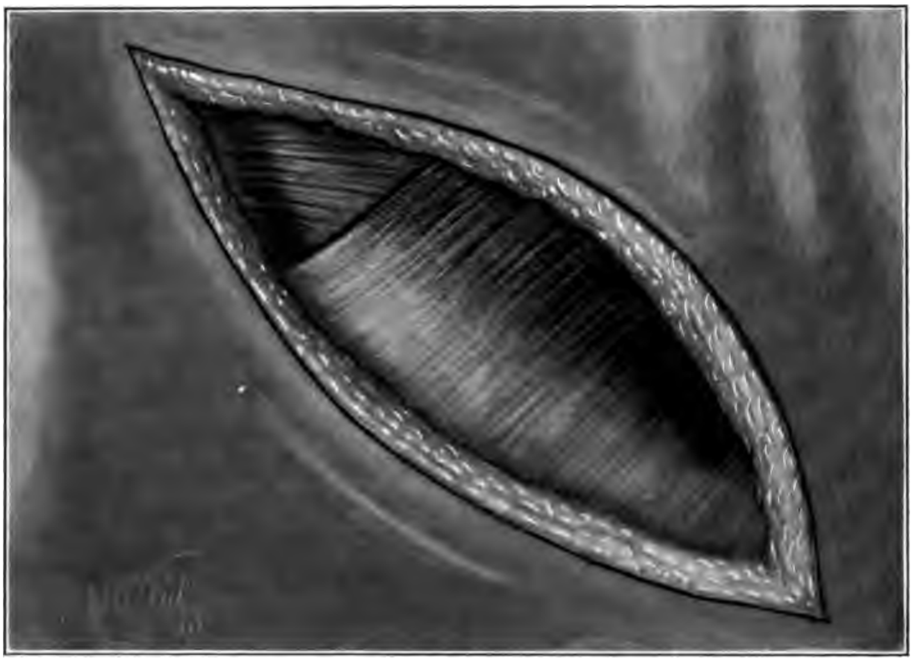
Fig. 412



Cunningham kidney operating table adapted to the usual form of operating table.

bored in a slanting direction at an angle of 30 degrees. They are for the purpose of receiving two stout round stakes, one of which is twelve inches in the length of the part of it which stands outside the hole in which it is placed; the other is six inches in length. The depth of the sockets or holes in which they are inserted is three inches. The longer of the two stakes is intended to press against the front of the abdomen, the shorter one to prevent the patient from rolling over onto his face when placed with the abdominal wall resting against the longer of the stakes. The long stake and the upper surface of the block of wood are padded

FIG. 413



First step in the exposure of the kidney by the lumbar route and by the incision parallel with the outer border of the quadratus lumborum muscle.

to avoid too great pressure being exerted upon the abdomen and the patient's side. The device has been incorporated in an improved and somewhat modified form in the ordinary operating table (see Fig. 412).

The patient is placed across the middle block of wood resting upon the side opposite that on which the kidney to be operated on lies. The ilio-costal space on that side should rest directly upon the upper surface of the middle block of wood. The front of the abdomen rests against the long stake. When the patient is rightly placed the short post is put in the hole that is close to his back and he is ready for the operation.

PLATE XLIII

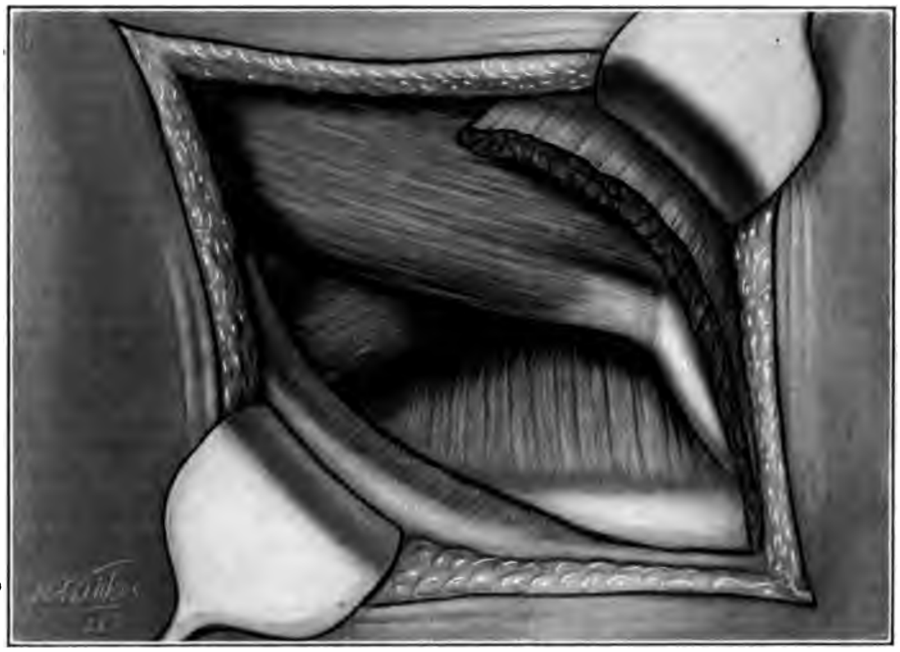
THE LUMBAR REGIONS STRIPPED OF THEIR OUTER COVERINGS.

On the right side, by means of the white rectangular lines, is seen one of the ways of exposing the kidney in the loin. On the left are shown the structures that are divided in exposing the kidney by the incision parallel with the twelfth rib, by the incision parallel with the border of the erector spinæ muscle, and by the combination of these two incisions when joined at their upper ends. The dotted line indicates the course of the ilio-inguinal nerve.

Incision (Plate XLIII).—1. *Parallel with the Outer Border of the Quadratus Lumborum.*—The incision extends from a point corresponding to the middle of the lower border of the twelfth rib—roughly, about four fingers' breadth from the vertebral spines—to the midpoint of the crest of the ilium. The succeeding incisions are made in the line of the first one. They proceed thus:

Operation.—Divide the skin and *superficial fascia* and expose the *outer border of the latissimus dorsi* which traverses the upper part of the wound obliquely in an upward and forward direction, and the *posterior fibers of the external oblique muscle* which appear in its lower part and have nearly the same direction as that of the wound itself (Fig. 413).

FIG. 414



The same operation. Second step.

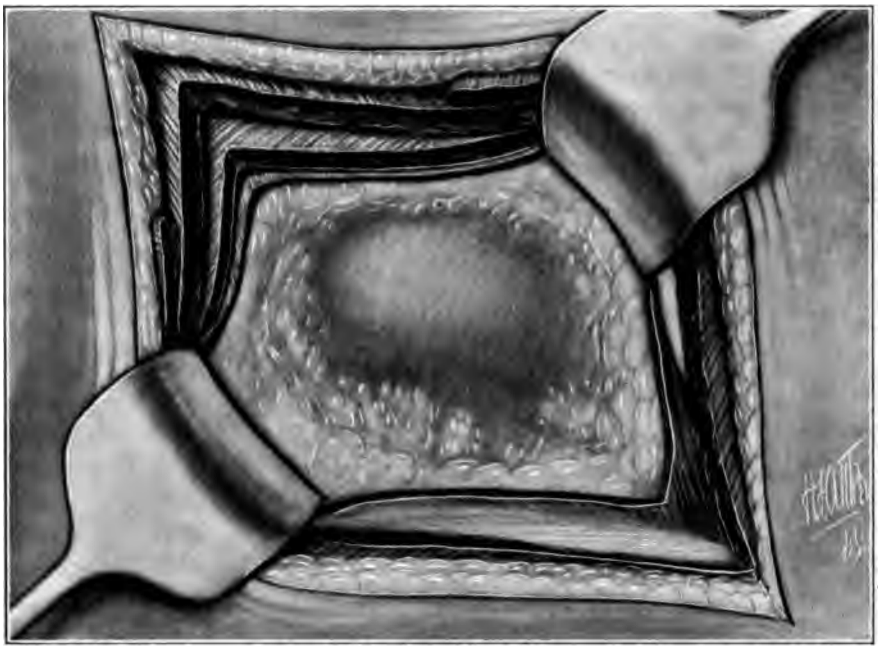
Divide the exposed fibers of both of these muscles. A small portion of the *serratus posticus inferior* is seen in the upper angle of the incision, traversing it in an upward and forward direction. Divide this portion of that muscle.

The *outer border of the erector spinæ*, inclosed within its sheath, extends longitudinally through the whole length of the wound. This muscle is *not to be incised*, and its *sheath is not to be opened.*

Drawing aside the margins of the wound, the posterior fibers of the *internal oblique* appear, crossing the lower part of the incision in an upward and forward direction (Fig. 414). Divide these fibers. Imme-

diately beneath the internal oblique and upon the transversalis fascia is the ilioinguinal nerve. Draw this to the posterior side of the wound with the retractor. The deep layer of the lumbar fascia is now exposed. Divide this and the chief landmark and guide in the exposure of the kidney—the outer border of the quadratus—is revealed. (Plate XLIII.) All that now covers the kidney are the *transversalis fascia* and the *perirenal fat envelope*. Divide the *transversalis fascia*. The perirenal fat at once bulges upward into the wound (Fig. 415). The colon and the peritoneum often protrude into the wound at the same time, and care must be taken not to injure them. Do not carry

FIG. 415



The same operation; the perirenal fat with the kidney outlined beneath it is exposed.

the incision too close to the last rib, since the twelfth rib is sometimes absent, and in that case the pleura descends as low as though it were present, and is then liable to be wounded if the incision extends actually to the lower border of the last rib. Should the pleura or peritoneum be accidentally opened, the wound should be immediately closed.

Isolation of the Kidney.—The kidney is best reached by working through the perirenal fat tissue with the tips of the forefingers, unless the fat envelope has been altered by previous inflammatory or other processes and has thereby become adherent and indurated; in this case it must be divided with blunt-pointed scissors.

Unless the operation is to be made an intracapsular one, the whole surface of the fibrous capsule of the kidney and the pedicle should be exposed. In doing this keep close to the capsule all the while. Begin at the lower pole; free first the anterior and then the posterior surface of the organ from its envelope, and finally clear the pedicle. Make sure before cutting any of the firmer bands traversing the perirenal fat envelope that they do not contain aberrant bloodvessels. If in doubt, clamp them with two pairs of forceps and divide the tissue between them. Tie any bloodvessels encountered in clearing the kidney, as they are met with. Cut the ligatures short.

FIG. 416

The kidney drawn out on the back and its pedicle compressed with the fingers. The splitting of the kidney here shown illustrates the operation.

Do not attempt to isolate a pedicle that is buried in a dense mass of adhesions. It is safer in such cases to remove the organ by morcellement or intracapsularly, or to ligate the pedicle in two or more portions by passing ligatures through it with an aneurysm needle.

Bringing the Kidney Out onto the Surface of the Loin.—The kidney having been isolated, it should be brought out onto the surface of the loin *when this can be safely done* (Fig. 416). Unless the pedicle is enveloped in adhesions, and if the bloodvessels are not too short, it can be readily done. Never put strong traction on the kidney to accomplish

the withdrawal of the organ to the surface of the body. The right kidney is more difficult than the left to bring outside of the lumbar wound, on account of the shorter renal vein on that side.

The Pedicle.—First find the ureter; isolate it a little below the level of the lower pole of the kidney. The ureter will be more readily recognized by the finger if the lower end of the kidney is raised, thereby putting the ureter on the stretch. This is said with reference to the cases in which the ureter must be found by the sense of touch alone; that is to say, in those in which the kidney cannot be brought out upon the back; when it can be brought into view on the back there is no difficulty in recognizing the ureter visually.

The ureter is often pushed forward with the anterior part of the perirenal envelope when this is being separated from the kidney, or because of having become adherent to the overlying peritoneum. The finger should search for it in front of the kidney, therefore, as well as below the organ.

Having isolated the ureter and bloodvessels, place a right-angle clamp upon them near the hilum. Protect the adjacent tissues by sterilized gauze strips passed around the ureter; pick up the latter and ligate it; cut the ureter across between the ligature and the clamp. Cauterize the divided ends of the ureter with nitric or carbolic acid. Attach the lower severed end of the ureter temporarily to the margin of the wound with a single suture, if the ureter is to be tied off lower down later; otherwise, let it drop back into the wound at once.

Pass an aneurysm needle carrying a strand of stout silk or of No. 2 chromicized catgut, as may be preferred, around the vessels and ligate them in one mass. Leave the ends of the ligature long for the moment, and divide the artery and vein between the ligature and the clamp (Fig. 420).

The vessels should not be tied too near the vena cava and aorta, nor so near to the clamp as to make it difficult to divide them between the ligature and the clamp. Remove the kidney.

The vessels may be tied separately if the operator prefers to do so. In that case, the needle is to be passed between them, and carries a double ligature, the artery being tied with one-half and the vein with the other.

We have never seen trouble result from ligating the two vessels in one mass; there is some danger, on the other hand, of injuring the vein if the needle is carried between it and the artery when they are tied separately.

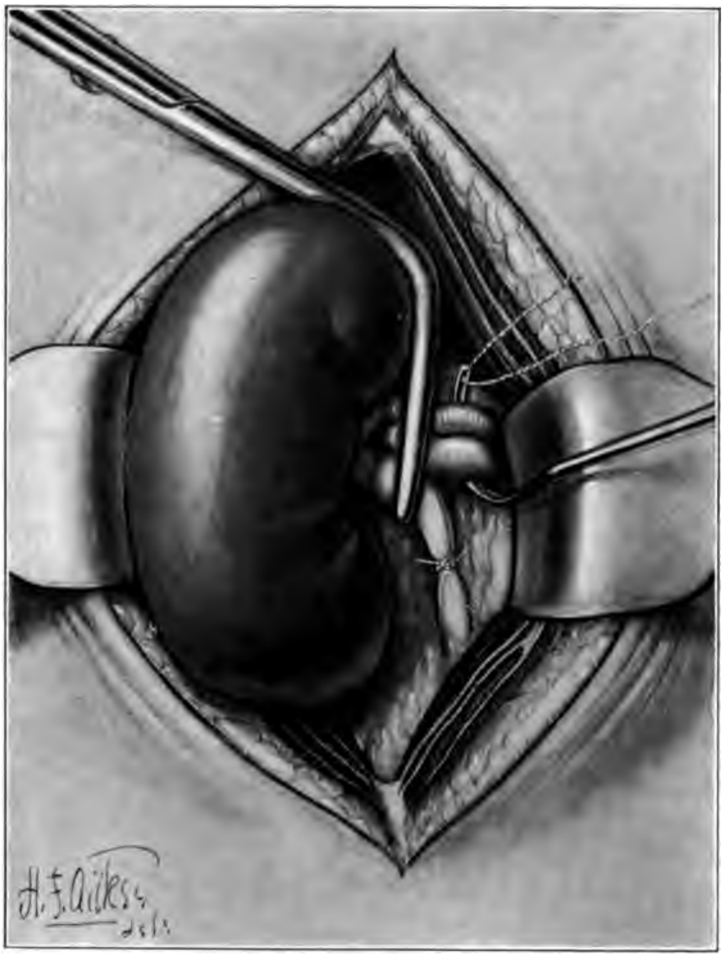
Precautions.—Do not ligate the vessels while a clamp is applied to them.

Do not fail to catch the proximal end of the ligatured bloodvessels

with a pair of forceps just outside the ligature before letting the stump fall back into the wound. If the ligature is not securely applied the vessels can be lifted up into the wound and another one applied, if the forceps have been placed as directed.

If the pedicle is surrounded by adhesions, ligate it in two or more bands with separate ligatures instead of tying it all in one mass with one ligature.

FIG. 417



Manner of clamping and tying the pedicle of the kidney.

If there are adhesions around the pedicle, do not attempt to separate the ureter near the renal pelvis or tie it off at that point, but follow it down a little below the lower pole of the kidney, and ligate and divide it there.

If the ureter is to be tied off low down, extend the original incision

along the crest of the ilium and downward over its anterior end, clear the ureter from its attachments, and tie it off at whatever point may be desirable.

Do not divide the ureter without placing a second ligature or a clamp between the first ligature and the renal pelvis.

Do not place the ligature on the bloodvessels while traction is being made on the kidney, else a bit of the vena cava may be included in the ligature.

Be careful, if the vessels are clamped, not to use too great pressure or too strong forceps, else the vein may be cut through by them.

Do not divide the vessels too close to the ligature, else the ligature may slip over the too small end thus made.

It is better to transfix the pedicle and tie it in two or more parts than to attempt to apply separate ligatures to its individual structures, in cases in which there are extensive or dense adhesions encasing it.

Do not overlook aberrant vessels, and do not divide the pedicle or remove the kidney until assured that all such vessels as may be present have been ligated.

After the Kidney Has Been Removed.—In cases of tuberculosis and of malignant disease of the kidney, all the perirenal, adrenal, as well as renal structures that are involved in the processes should be removed, so far as may be safely done.

Cleanse the operative field; tie all bleeding points not already secured.

In the cases in which there are non-infective or non-malignant processes, the outer wound may be closed tight without drainage. In all other conditions a space, or two spaces—one at either end of the wound—should be left open to allow the passage of a gauze or other drain.

Modifications of the Lumbar Operation.—All the modifications devised of the lumbar operation have the same object in view, viz., to secure more room. They are as follows:

1. Single incisions so placed as to allow of greater length being given to them than in the operation already described.

2. Incisions composed of two cuts, the second one being at a greater or less angle with the first and proceeding from its upper or lower end.

3. Single incisions curved at one or both ends.

The more important of the various modifications are shown in Plates XLIII and XLIV and Fig. 418.

When the ureter is to be tied off low down, either the lumbar incision already described, or one which is parallel with the lower border of the twelfth rib, can be prolonged (Fig. 418), the peritoneum drawn away from the line of the cut and from the ureter, and the latter is thus exposed in its lower segment.

PLATE XLIV

ANTERIOR INCISIONS FOR EXTRAPERITONEAL EXPOSURE OF THE KIDNEY.
(Mayo Robson and Bardenheuer.)

Also the incision for the so-called "paraperitoneal" operation, which is made by adding the transverse cut indicated by the white line.

Bergmann and Mayo Robson employ oblique and longer incisions farther forward toward the front of the abdomen. That used by the former passes from the tip of the eleventh rib, in front of the anterior superior spine of the ilium, and to, or near to, Poupart's ligament (Plate XLIV); that of the latter, from the tip of the twelfth rib to the anterior superior spine of the ilium.

Fig. 418

The lumbar incision prolonged for the purpose of exposing the ureter extraperitoneally.

In making the incision parallel with the lower border of the last rib, care must be taken not to wound the peritoneum. The injury to it can be avoided by drawing it toward the front of the abdomen and maintaining it there with a suitable retractor.

Morris advises that the last one or two ribs be resected for a short distance if a freer space is needed. We do not favor this step, for it requires some time to carry it out; there is always the chance in doing

it of wounding the pleura, and the same, or even more, room can be gained better in other ways.

2. The approach to the kidney which is secured by *combining two incisions* or by prolonging the lower end of the usual oblique incision forward toward the anterior abdominal wall, is that which we prefer when more space is needed. It is better, we think, to employ the form of incision which passes forward from the upper end of the usual oblique cut first described than to gain room by adding to the lower end of it (see Plate XLIII), for the reason that the prolongation from the upper end gives more direct access to the kidney itself and to its pedicle. The only advantage of making it from the lower end is that by so doing it is easier to follow down the ureter through this incsion when it is desired to tie it off near the bladder.

If the first incision has been that which is parallel with the lower border of the twelfth rib, the second or additional cut will be that used in the ordinary oblique method of exposing the kidney, viz., the first incision described, making the additional one the incision parallel to the lower border of the rib and proceeding from the upper end of the first one. (Plate XLIII.)

The triangular flap thus made and turned back gives all the space required in all but very difficult cases, and the latter are best approached from the anterior wall of the abdomen, in the manner that is described later in the text.

3. There are two which we mention, though we do not see any advantage to be gained by either that is not equally well afforded by the other forms already spoken of. These two are the horizontal H incision of Bergmann and the horizontal U of Lecène.

The objection to the incisions of Bergmann and of Mayo Robson (Bergmann's first incision described) is that they weaken the abdominal wall, because of being so long and because of being placed so far forward upon it. Per contra, they both have the advantages of giving access to the ureter, and they both afford a wide avenue of approach to the kidney and to its pedicle.

We prefer the incisions of triangular shape placed farther back, since they are not open to the objections just stated, or that made by prolonging the usual oblique incision in the manner described when speaking of that method of approaching the kidney, for by the latter the ureter can be reached also. We believe that it is better to employ the transperitoneal or paraperitoneal methods when very free space is required in order to remove the kidney, in some of the difficult cases.

The Paraperitoneal Method (Trelat, Antona, Krönlein).—The distinctive feature of this method is that the kidney is exposed through

the anterior abdominal wall without opening the peritoneal cavity. It is carried out as follows:

Position of Patient.—This is the same as for any ordinary laparotomy incision; that is to say, lying flat on the back.

Incision.—From the free border of the ribs nearly to the anterior superior spine of the ilium and just a little outside the linea semilunaris. It is along this line that the peritoneum can most easily be detached from the abdominal parietes. The incision divides all the tissues down to, but not through, the peritoneum. Proceed as follows (Fig. 419; see also Plate XLIV):

FIG. 419

Paraperitoneal nephrectomy and stripping the peritoneum from the abdominal parietes.

Detach the peritoneum along the line of the incision and as far out as its reflection from the lateral aspect of the abdomen; draw it toward the median line, and retain it there with large pads and retractors. The peritoneum is stripped off by the hand (Fig. 419). The peritoneum, its underlying colon, and the intestines are drawn toward the middle line of the abdomen and retained there by pads. The kidney can now be exposed and isolated.

If a still freer space is needed, a second cut should be made at right angles to the first one and beginning a little above its centre. It is extended transversely as far as the outer edge of the quadratus if need be. Ordinarily, it is not necessary to extend it to this point (see Plate XLIV and Fig. 419).

This method has the advantages of the transperitoneal operation and the additional one of not opening the peritoneal cavity. Sometimes, however, that accident does occur when the peritoneum is adherent to the anterior surface of a renal tumor, or is involved in the mass of adhesions which, in some conditions, surround the kidney. We have employed this method in eight or nine cases, and have liked it. If the peritoneum is torn, the wound can be sutured at once, and thus the extraperitoneal character of the procedure may be maintained.

Abdominal or Transperitoneal Nephrectomy.—Operation.—The abdomen is opened through the linea semilunaris. This having been done, draw the intestines away from the front of the kidney and retain them by large pads.

The bloodvessels supplying the colon pass to it through the *inner* leaf of the mesocolon. The incision which exposes the kidney is, therefore, to be made through the *outer* leaf of the membrane. (Plate XLV.)

In some cases the two leaves of the mesocolon are so closely approximated that the bloodvessels are likely to be wounded when dividing the outer one. This condition is more often seen on the left than on the right side.

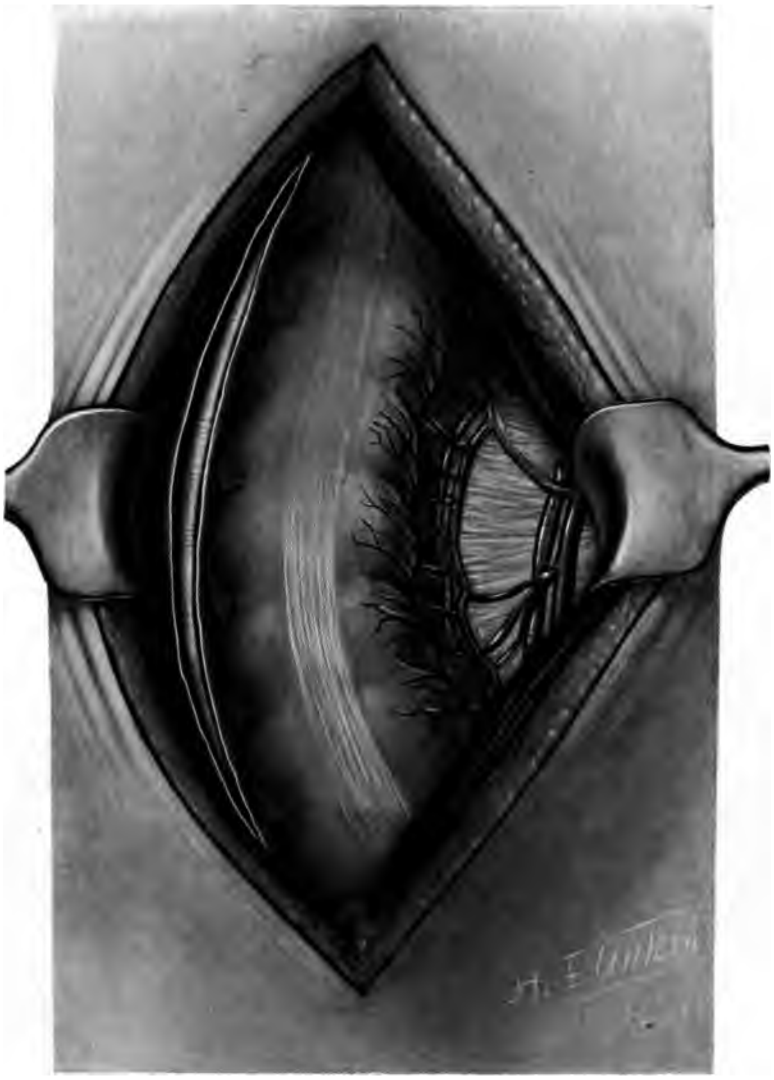
It is also to be remembered that the mesocolon of the descending colon is shorter and placed more externally with reference to the middle line of the body than is that of the ascending colon. The performance of abdominal or transperitoneal nephrectomy on the left side is, therefore, rendered somewhat more difficult than is the same operation on the right.

In dividing the outer leaf of the mesocolon, care must be taken to avoid injury to the large bloodvessels beneath it which traverse the surface of some renal tumors.

The incision in the mesocolon may be made parallel to the line of the colon or at right angles to it. The former gives more room and exposes the kidney more freely, but incurs greater danger of cutting the bloodvessels in the cases in which the two leaves are apposed, than the latter, while the contrary is true of the other incision.

As soon as the mesocolon has been divided the pedicle is to be cleared of its surrounding tissues (Fig. 420). The same rules and the same precautions as those which have already been given with regard to these steps are to be observed. The pedicle should be dealt with in the same

PLATE XLV



INCISION IN THE OUTER LEAF OF THE MESOCOLON MADE IN REACHING AND EXPOSING THE PEDICLE OF THE KIDNEY IN THE TRANS-PERITONEAL OPERATION.

The blood supply passes to the bowel through the inner leaf of the mesocolon and is not injured by the incision through the outer leaf.

way as that described in connection with the lumbar operations and similarly varied according to the different conditions that may be encountered (Fig. 421).

The operation may be rendered, practically speaking, an extraperitoneal procedure by suturing the cut edges of the mesocolon to those of the abdominal wound. After the kidney has been removed these sutures are

FIG. 420

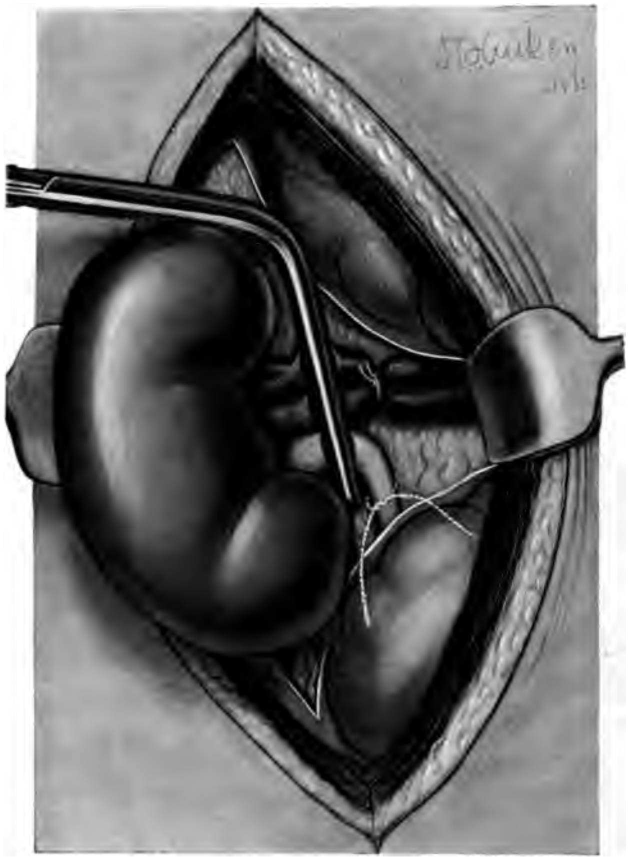
Drawing the intestines away from the kidney and opening the incision in the mesocolon to expose the pedicle of the kidney.

cut and the peritoneum is sutured together again, unless the patient's condition is too critical to permit of its being done. The abdominal incision should be closed tight, and drainage should be provided by a counter-opening in the loin.

The objection to the abdominal route is the liability to infect the peritoneum which is involved in the method. It is, therefore, an unde-

sirable procedure to employ in cases of renal suppuration; moreover, it is unnecessary to resort to it in most of the cases of that character, since the size of the kidney, when so great as to tempt the operator to approach it through the peritoneum, can be reduced by aspiration, after exposing the kidney by a lumbar incision, and the organ can then be removed, as a rule, without great trouble.

FIG. 421



Clamping and ligating the pedicle of the kidney in the transperitoneal operation.

The transperitoneal and the paraperitoneal operations are especially valuable in the cases of lacerated kidneys and in those of large renal tumors.

The Removal of the Kidney by Morcellement.—In cases in which extensive and dense adhesions exist the kidney is more safely removed in separate pieces than in one mass.

Operation.—Expose and isolate the kidney in the manner already described in connection with the lumbar operations.

Clear the lower pole of the organ and apply a right-angle clamp forceps to it in a direction transverse to its long axis. Cut off the part of the kidney which is below the blades of the instrument. This gives access to the pedicle. Clamp the pedicle with a pair of right-angle forceps, sliding one of the blades on either side of the ureter and vessels.

Clear the rest of the kidney, which can now be safely done in most instances. When the whole of it cannot be separated from the adhesions, as much as can be isolated is clamped in the same manner as that described above, and the part below the blades of the instrument is cut away. This will generally make it possible to bring the rest of the organ into view and to remove it.

In some instances the whole of the pedicle cannot be clamped until the middle part of the organ has been removed. When this has been accomplished a second clamp can be placed upon the rest of the pedicle and the upper end of the kidney can then be removed without danger.

If it is not possible to securely ligature the bloodvessels of the pedicle, which is sometimes the case, owing to the mass of adhesions by which they are surrounded, it is better not to attempt to do so, but to leave the forceps *in situ*, removing them on the second or third day following the operation, by which time the vessels are sealed and all danger of hemorrhage is passed.

Partial Nephrectomy or Resection of the Kidney.—The manner of carrying out this operation necessarily varies according to the size, situation, and character of the condition for which it is undertaken. It is of service in some cases of traumatic lesions of the kidney, of cysts, and of benign tumors of moderate size.

When possible, the part of the kidney removed should be given the shape of a wedge, the apex of which lies in the deeper part of the organ and the base on its surface.

When it is one pole of the organ that is to be removed this wedge-like form enables the operator to approximate the cut surfaces better than if the incision passed transversely through the kidney.

When the part of the organ that is to be taken away has been removed the cut surfaces should be brought together with sutures. More than one piece of the kidney may be taken away. Morris removed three separate bits of the organ in one instance.

Czerny, in 1887, was the first surgeon to do the operation. He removed an angiosarcoma of the size of a small apple, together with the middle third of the kidney. The resulting wound was partly closed by suture, the remainder was tamponed. The patient made a good recovery and was under observation for one year subsequently, during which time he remained well. Czerny's case demonstrated that it was possible to

have a wound of the kidney that was not wholly closed by suture, heal without fistula.

Thiriar and Bardenheuer demonstrated on dogs that healing by first intention of renal wounds took place after wedge-shaped resections of parts of the organ.

Tuffier demonstrated experimentally that cut surfaces of the kidney very soon after being incised ceased to secrete urine, and assumed that this was one reason why renal fistula does not necessarily follow this procedure.

The following are some of the cases in which the operation has been performed:

Conditions for which the operation was done.	Cases.	Deaths.	Later results.
For renal tuberculosis	..	..	5 recovered; 4 cured.
Morris	6	0	1 death at end of 3 mos. of tuberculosis.
Schmieden	7	1	2 had secondary nephrectomies; both recovered. One other patient recovered with fistula; 2 were cured.
For malignant tumors (Schmieden)	5	1	4 recovered; 2 cured; 2 secondary nephrectomy.
For benign tumors (Schmieden)	8	1	1 secondary nephrectomy; 6 cured.
For renal suppuration	5	1	2 recovered with fistulas; 2 cured.
For traumatic lesions	4	0	2 cured; 2 failed to heal.
For hydronephrosis	3	0	3 cures.
For nephritis	2	0	Both cured.
	40	4	

Operative mortality, 10 per cent.; healed with fistula, 4, or 10 per cent.

Nephrectomy in Cases of Renal Fistula.—Operation.—Pass a probe into the fistula; dissect the mouth of the passage from the adjacent tissues and tie a ligature around it and the probe.

With the probe as a guide, dissect the tract from its bed down to the kidney, taking care not to open it in so doing.

The kidney can now be removed in the manner already described, leaving the probe in the fistulous tract; or, when it can be done, tie off the fistulous tract with a ligature placed close to the kidney, remove the probe with the remainder of the tract attached to it, and then proceed with the nephrectomy.

The object in view in dealing with the fistulous tract in this manner is to avoid infection of the operative field.

Special Difficulties Encountered in the Performance of Nephrectomy.—Adhesions.—These may be so extensive and so dense as to make it impossible to detach the kidney from its bed without tearing the organ.

In such cases the pedicle must be secured before the kidney is mobilized. When this cannot be done with safety the kidney must be removed subcapsularly or by morcellement in the manner already described.

In a number of cases the kidney will be closely adherent to the peritoneum covering the neighboring intra-abdominal organs, and its removal will be made difficult because of the danger of injury to them. The parts of the adhesions which bind the kidney to them should be cut away and left attached to the under surface of the peritoneum.

The process of isolating the pedicle is made dangerous by the presence of dense adhesions about it, because of the liability of tearing the renal vein, because the pedicle is usually shortened by the contraction of the connective tissue which has formed about it.

These conditions are sometimes best met by an intracapsular removal of the kidney. One of the surprising features of this operation is that it is sometimes unnecessary to tie any vessels at all. Their constriction and, in a few instances, almost absolute obliteration by the pressure of the contracting mass of connective tissue about them is such that the separation of the kidney—shelling it out of this bed—causes no bleeding.

After the kidney has been removed, as much of the envelope from which it has been shelled out as can safely be cut away should be trimmed off. In doing this, it is safer to place separate ligatures about the parts to be cut away, beyond the line through which the incisions are to be made, taking up the tissue in separate bundles, each of them being ligatured by itself. It is important to remove as much of the tissue enveloping the kidney as possible in cases of malignant disease and of tuberculosis. The failure to do so in the latter cases frequently results in the formation of fistula and in the propagation of the disease.

Hemorrhage.—The special dangers from hemorrhage in connection with certain conditions met with in doing nephrectomy have already been spoken of. One other point may be noted, which is, that aberrant bloodvessels should not be ligated too near the intestine. This is liable to happen, especially if traction is made upon the forceps that hold the vessel while the ligature is being applied. Failure to observe this precaution may result in perforation of the bowel from necrosis at the point of ligature.

In case of wounding the vena cava, pressure should be made at the site of injury and the vein should be ligated above and below this point, or the wound in it may be sutured. Hartmann has ligated the vein in one case with success. Direct pressure will control the bleeding when it is from the vein. In Hartmann's case it was maintained until the kidney had been removed and its pedicle tied; the ligatures were then applied above and below the wound in the vena cava (Hartmann[1]).

The renal vein may be torn by allowing a heavy kidney to drag upon it.

Relative Mortality of the Lumbar and Transperitoneal Methods.—The operative mortality, in a general way, may be said to be higher in the abdominal than in the lumbar method of doing nephrectomy. This, however, is not the only factor determining the selection of the one or the other of them in the individual cases; the conditions which exist in each instance are equally important to the choice.

There has been a gradual diminution of the death rate of transperitoneal as compared with the lumbar operation, and the operative mortality connected with both of them has grown steadily less. This fact is well shown in the series of 1118 cases in which nephrectomy was done for various conditions, and which were collected and reported by Schmieden.[2] The period in which these operations were performed was from 1870 to 1900. This was divided into three decades, and the mortality attending the lumbar and the abdominal operations, respectively, was seen to be as follows:

	Mortality. per cent.
Lumbar:	
First ten years	43.9
Second ten years	26.9
Third ten years	17.0
Abdominal:	
First ten years	55.0
Second ten years	48.0
Third ten years	19.4

With respect to the special conditions for which the operations were done the following data are given:

	Mortality. per cent.
Hydronephrosis:	
Lumbar	10.8
Abdominal	27.0
Pyonephrosis:	
Lumbar	23.2
Abdominal	22.2
Pyelonephritis and Nephrolithiasis:	
Lumbar	32.0
Abdominal	41.0
Tuberculosis:	
Lumbar	27.0
Abdominal	42.0
For Malignant Tumors:	
Lumbar	28.0
Abdominal	38.0

Lumbar nephrectomy is made difficult by the following conditions:

1. A very stout patient with short iliocostal space.

2. Large size of renal tumors, which are solid, and which are adherent to the adjacent structures.

3. Very extensive and dense adhesions, especially such as surround the pedicle.

All these conditions are better treated by transperitoneal than by the lumbar method. Per contra, suppurative processes of the kidney, and all other renal conditions not offering the special difficulties to the performance of the lumbar operation, should be approached through the loin.

NEPHROTOMY.

Preparation of patient and position same as for lumbar nephrectomy.

The kidney is exposed, isolated, brought out on the back, and its blood-vessels compressed in the manner already described under Nephrectomy. If the operation is an exploratory one, proceed as follows:

Incise the cortex of the kidney sufficiently to admit the tip of the forefinger. This incision should be made through a line one-quarter of an inch posterior to the highest part of the convex border of the organ and parallel with the long axis of the kidney. The incision should be carried into the renal parenchyma sufficiently deep to open the calyx which lies nearest the point at which the cut has been made. (The position of the incision in an ordinary exploratory operation should be a little below the junction of the lower and middle thirds of the kidney.) Through this opening the finger tip is inserted and the renal pelvis and calices are investigated. The examination of the calices is best made with a probe having a rounded end of sufficient size not to penetrate their walls. If it is desired to examine the whole interior of the organ the incision should be extended through its whole length (see Fig. 416).

In the cases in which there is no suppuration or other contra-indication to its employment the renal incision should be closed at once by suture. The outer wound may likewise be closed without drainage, but it is safer to keep a gauze drain extending to the kidney for two days. When suppuration exists drainage should always be employed.

The position of the incision and its length will vary according to the nature of the conditions that are presented. The closure of the renal and outer wounds will be determined upon the same grounds. In *cases of abscess* of the kidney, the incision should be made through the kidney substance directly overlying the collection of pus.

When *a stone* can be felt through the renal substance, the incision for its removal is best made through that part of the organ which is directly

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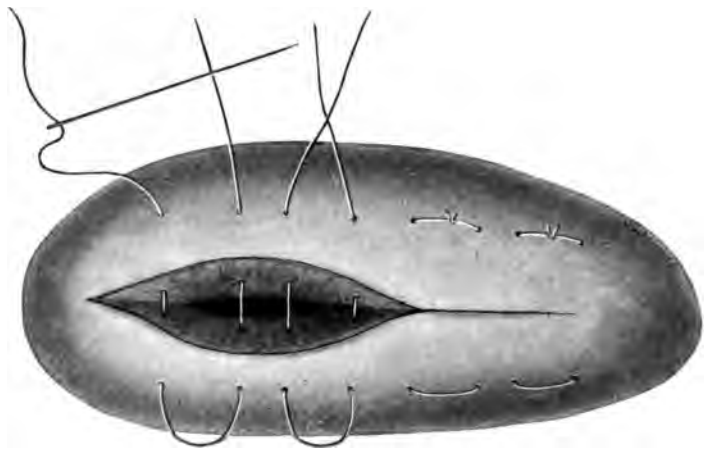
between the middle and forefingers of one hand (see Fig. 416) or by applying moderate pressure to them by a pair of forceps with blades curved at an angle with the handles and guarded by a bit of rubber tubing passed over each blade.

Tampon and Suture to Control Hemorrhage.—Tampon.—The renal incision often produces profuse hemorrhage from the cuts urfaces of the kidney. To arrest this, either tampon or suture is used. Tamponing the kidney consists in packing the renal wound with sterile gauze. It is not always a successful method of controlling the hemorrhage, and is open to the serious objection that the bleeding is very likely to be renewed upon removing the packing.

FIG. 422



Manner of applying suture to close the incision in the kidney.

Suture.—Suture, when it can be employed, is by far the most satisfactory manner of arresting bleeding from the incised kidney. The sutures may be applied in several ways. Of these, a single or double row mattress sutures is to be preferred (Fig. 422); the employment of a double or of a single line of these sutures is determined by the depth and extent to which the kidney substance has been divided and upon the degree of hemorrhage present in any given case.

It must be remembered that the kidney tissue is very friable, and that it will be cut through by a suture if it is drawn at all tight. Fortunately strong pressure is not required to arrest bleeding from the kidney, and merely approximating the cut surfaces is ordinarily quite sufficient to accomplish the purpose. The suture material should always be soluble. *Chromicized* catgut is too long in dissolving, and we do not employ it for this purpose.

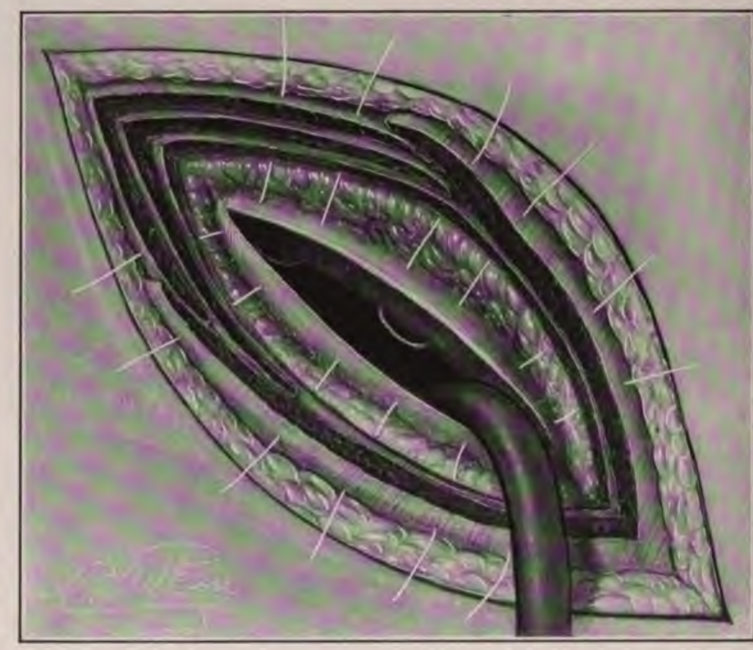
In the cases in which the kidney cannot be mobilized, suture may be impossible to apply. Under these circumstances tampon must be used.

RENAL DRAINAGE (NEPHROTRESIS).

The establishment of long-continued or permanent drainage of the kidney is sometimes necessary in cases of hydronephrosis and pyonephrosis, and in obstructive conditions of the ureter which, for one reason or another, cannot be remedied.

Desiderata of Renal Drainage.—The essential factors of long-continued or permanent drainage of the kidney or kidneys are: (1) That the channel of communication between the kidney and the surface of the body shall

Fig. 423



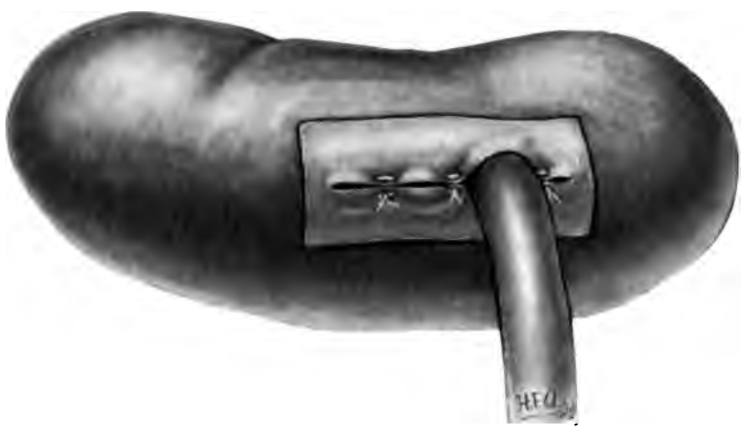
Suture of the edges of the renal incision to those of the outer wound, and drainage tube placed in the kidney.

be kept free and sufficiently large to insure the unobstructed escape of urine from the organ through it. In order that this may be secured, it is absolutely necessary that a tube should be kept constantly, or the greater part of the time, in the fistulous tract, and that the end of the tube shall occupy a place in the kidney which will give free exit to the urine. (2) That the patient shall be kept dry. (3) That the contrivance, whatever it may be, which is worn for this purpose, shall be neither unsightly to others nor uncomfortable to the wearer. The writer believes that all these

features are embodied in the apparatus which he has devised for the purpose. This contrivance will be described a little later in the text. Before referring to it in detail, it remains to speak of the special steps of the primary operation.

The only difference between an ordinary nephrotomy and the operation by which a permanent drainage of the kidney is arranged consists in attaching the edges of the renal incision to those of the lumbar wound. This is done by placing a row of mattress sutures on either side of the incisions just referred to, in the manner shown in Fig. 423, after which the kidney and lumbar incisions are brought together by another row of sutures, thus closing them around the drainage tube. The latter is at first held in place by a stitch passed through it and through the skin, at the point at which the tube emerges upon the surface.

FIG. 424



Closure of the renal incision around the drainage tube, in cases in which decapsulation is done. A small part of the capsule is retained to support the sutures.

If decapsulation of the kidney is done, in combination with drainage, a bit of the fibrous capsule should be left about the incision in the kidney, and the stitches closing the wound are placed as seen in Fig. 424.

The Author's Contrivance for Drainage of the Kidney through the Loin.—The apparatus consists of the following parts:

1. A cup-shaped hard-rubber shield perforated by two holes, one in the centre of the shield and having the size of 28 of the French scale of measurements for urethral instruments; the other, which is somewhat smaller than the first, is placed just within and at the lowest point of the cup of the shield. A short hard-rubber tube is fitted into the last-named hole, and onto the farther end of this tube is attached another of soft

rubber, which passes to the smaller of the two upright tubes of metal that are upon the upper surface of the receptacle (Fig. 425).

The leakage, which is so distressing a feature to the patient, and which, because of the urinous odor, makes it so unpleasant to others, takes place around the outer sides of the tube which drains the kidney. It is this leakage which must be provided for by the apparatus, and it is done in a very simple manner by this contrivance, thus: As fast as the urine escapes upon the surface of the body it is necessarily caught within the cup of the shield and is withdrawn from it by the small tube which

FIG. 425

Cup-shaped hard-rubber shield of Watson's apparatus for permanent renal drainage through the loin.

drains the latter as fast as the urine collects in it and conveys it to the receptacle. The shield is provided with a soft-rubber rim, which fits into the raised edge of the rubber cup, and the shield is kept firmly pressed against the surface of the body by an elastic belt which is attached to each of its wings and which buckles in front (Fig. 426).

2. A receptacle made of German silver which has a capacity of nine ounces.

3. A second belt, which is attached to the receptacle in the manner shown in Fig. 426, and which also passes around the body and buckles in front.

4. Upon the lower part of the can is a metal cap, which can be detached from it. From the middle of this cap projects a short metal tube, over the end of which a soft-rubber tube is slipped; the further end of this tube is furnished with a hard-rubber cap, by unscrewing which a hole is opened in its stem and allows the contents of the can to escape through it. Except at the time at which the can is being thus emptied, the end of the tube is worn beneath one of the elastic belts, which retains it at whatever point is most convenient to the wearer (Fig. 426).

FIG. 426

The various parts of the apparatus.

5. The only other feature of the apparatus which requires description is the arrangement by which the tubes connecting the shield with the receptacle are attached to the latter. This is done by passing the lower ends of the soft-rubber tubes into the two metal nozzles (or, if preferred, slipping them over them) which are placed upon the upper part of the receptacle. The manner in which the connection is made, as well as the relative positions of the shield and receptacle and other details of the apparatus, are shown in Figs. 426 and 427.

Fig. 427 shows the apparatus as it appears when properly placed upon the patient's back.

The further points to be noted in connection with it are as follows:

The hole in the shield through which the tube which drains the kidney passes must be a little smaller than the tube, in order that the latter shall bind in it and thus be prevented from slipping to and fro. If in any case the tube should be too small to do this, its size can be increased by slipping over it a short bit of another and larger tube at the point at which it passes through the shield.

FIG. 427

Watson's apparatus for permanent drainage of the kidney, showing manner of wearing it.

The receptacle can be worn inside the trousers, and is so small and flat that it attracts no attention and causes no discomfort.

Instead of a receptacle of this form the ordinary portable rubber urinal, which is attached to the leg, may be worn if preferred, the connecting tubes being united into one, near the shield, and lengthened, as may be required. The objection to this arrangement is the difficulty of keeping the rubber bag clean and odorless.

At night the metal receptacle is detached, the tubes of the shield are lengthened by attaching others to them, and these are carried to a bottle

or other receiving vessel placed beside the bed. The patient should assume a semirecumbent position at night in order to secure the best drainage of the cup of the shield.

The connections of the belts with the shield and can respectively should be so arranged as to be detachable, in order that the other parts of the apparatus can be boiled, which should be done once daily. The tube draining the kidney should be changed for a fresh one each day, the one not in use being kept in an antiseptic fluid.

When the tube which drains the kidney has been properly adjusted in the organ, a mark should be made upon it at the point at which it emerges from the outer side of the shield, in order to avoid the necessity of having to readjust the tube each time that it is changed.

The tube's inner end should rest within the renal pelvis in most cases, and should be so placed as to cause no pain to the patient.

NEPHROLITHOTOMY.

Position same as that of lumbar nephrectomy. Instruments also the the same, except that for nephrolithotomy there should be added two or three scoops of different sizes, a long probe with which to explore the whole length of the ureter, and forceps for extracting stone from the kidney.

The kidney should be approached through the loin—in the first instance, at any rate—in all cases. The field of operation can be subsequently enlarged, if it be desired to do this, by one or another of the methods described under Lumbar Nephrectomy.

Operation.—The operation is the same as that of lumbar nephrotomy, until the kidney has been reached. The place at which the renal incision is made will vary according to the location of the stone and whether it has been seen beforehand by the *x*-ray photograph or can be palpated at the time of the operation.

If it has been located by either of these means the incision is best made directly through that part of the kidney which overlies it. When its position in the kidney has not been made out, the regular incision for exploratory nephrotomy, already described when dealing with that part of the subject, should be selected.

There must always be some doubt whether or not there is more than one stone present, and if the incision through which a previously located calculus has been withdrawn does not permit a complete exploration of the whole interior of the kidney and its pelvis, the first cut should be extended or a second one made that will afford the opportunity to do this and to pass a long probe into and through the ureter.

If the ureter cannot be entered and explored through the renal incision just referred to, the lower end of the kidney should be raised, and the ureter having been thus made tense, and more easy to trace, it should be followed down in order to learn if there is a calculus in the canal or anywhere between the renal pelvis and the bladder. Another way to explore the ureter is to pass a probe into it through a small opening made in the renal pelvis. This incision may sometimes be utilized to withdraw the stone should one be found in the upper part of the ureter. It should be closed by suture when this has been done.

When possible the calculus should be extracted in one piece. The difficulty of finding fragments if the stone has been broken is often great.

When a calculus lies in the pelvis and sends branches into the calices, the renal tissue overlying them should be divided from within the interior of the previously laid open kidney, in order to permit the stone to be extracted, rather than to attempt to remove it without so doing, for the latter procedure will lacerate the organ needlessly and perhaps dangerously.

The stone is often intimately adherent to the renal tissue surrounding it, and its extraction under these conditions is likely to be attended by severe bleeding.

After the removal of the calculus the whole interior of the organ should be freely irrigated and explored for any fragments that may have been overlooked.

Small calculi may be removed by the finger tip, scoop, or with small forceps. If a small calculus, or fragment, has been once felt by either finger or probe, do not lose touch of it until it has been grasped by the blades of the extracting forceps, for it has often happened that the failure to observe this precaution has resulted in the calculus not being found again.

Complications and Difficulties Attending the Performance of Nephrolithotomy.—Hemorrhage.—Hemorrhage is the most serious danger that is encountered in the performance of this operation. It is likely to arise from the breaking down of the partitions which separate the chambers of the pyonephrotic kidneys which, as has been shown, occur in a certain number of the cases of renal calculus. The more serious chance of its taking place is, however, from the detaching of an adherent calculus, and worse yet, one which has caused ulceration into one of the larger branches of the renal bloodvessels. So long as the stone which has penetrated a vessel in this way plugs the hole that it has made into it, no bleeding takes place, but the opening of the hole caused by the removal of the calculus may result in very severe bleeding, even to the point of endangering the life of the patient. When such a condition as this seems

likely to be present, the stone should not be extracted until the operator has control of the renal bloodvessels and can compress them should the emergency arise.

NEPHROPEXY OR NEPHRORRHAPHY—FIXATION OF THE KIDNEY.

This operation was introduced by Hahn in 1881. Hahn's method consisted in exposing the kidney by a lumbar incision parallel with the border of the erector spinæ muscle, separating the perinephritic fat as far down as the kidney and then passing sutures through the edges of the fatty envelope thus divided and through the margins of the outer wound. This manner of attempting to attach the kidney was ineffectual and was soon abandoned.

Bassini passed sutures through the fibrous capsule of the kidney and the edges of the outer wound in 1882.

In the same year, Weir, in America; Küster, Esmarch, and Delhaes, in Germany, did the operation; and in 1883 Newman, in England, introduced it into that country; while the first operation in France is credited to Bazy, in 1885.

Küster was the first to do a bilateral nephropexy at one sitting. This was in 1883.

Newman, in his work published in 1888, says that at that time there had been but 23 nephropexies reported. Since then there have been many hundreds of cases published, and the operation has become one of the most thoroughly established, as well as one of the safest, of surgical procedures.

The *position* for unilateral nephropexy is the same as for lumbar nephrectomy.

The *instruments* are the same as those for lumbar nephrotomy, with the addition of a needle of special form, which is used by some surgeons for setting the sutures in the kidney. Whatever the form of the needle, it should be without cutting edges and should have an eye large enough to take No. 2 catgut suture. The suture material should be soluble. We prefer No. 1 or No. 2 plain catgut.

If both kidneys are to be operated upon at the same time the patient should be placed upon the abdomen across the block of the Cunningham table or upon such contrivance as the air cushion of Edebohls (Fig. 428).

The *incision* is the same as that for lumbar nephrotomy, viz., parallel with the outer border of the quadratus lumborum muscle.

General Considerations.—The desiderata in the operation of nephropexy are as follows:

1. It should be done in such a way as to create adhesions between the kidney and the posterior abdominal wall. This implies partial decortication of the organ.

2. Suture should not be applied to the lower end of the kidney only, for if this is done the upper part of it may drop forward and produce a twist of the ureter.

3. The kidney must be fixed in such a position as to insure the free passage of urine through the ureter. It is not necessary for this purpose, nor is it possible, to attach the kidney in its normal position.

4. The sutures should always include the fibrous capsule, for the renal substance is too friable to hold the stitches.

5. A suture which passes through a considerable part of the kidney is preferable to one that is set in a very little of it only.

6. It is unnecessary and undesirable to attach the kidney to the lower rib.

7. In cases of abnormally mobile kidney, the organ can always be brought out upon the loin, and, if desired, this may be done previous to placing the sutures.

FIG. 428

Edebohls' pad for operations on the kidney.

Special Methods of Performing Nephropexy.—The features of the more important ways of doing the operation are as follows:

1. Without incision of the capsule and without decortication of any part of the kidney.

2. With incision and with partial decortication of the kidney.

3. With the sutures passed through the renal capsule only.

4. With the sutures passed through the capsule and the renal substance as well.

5. Without suture of any kind.

6. By suture which attaches the kidney to the last rib.

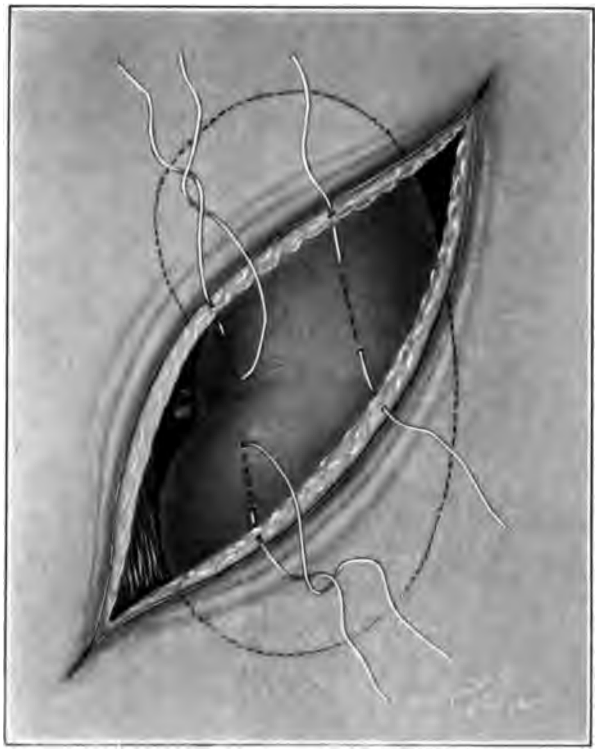
7. With complete or with partial closure of the external wound.

Many different ways of attaching the kidney to the posterior abdominal parietes have been devised. Some of them are objectionable, a number of them are good, but are not better, one than another. We have, therefore, selected three of those which illustrate certain special features from

among the latter class, and which are without the objectionable qualities attaching to those of the first class referred to.

The first operation to be described is that of Morris, which does *not* include decortication of any part of the kidney, and in which the sutures pass through both the capsule and the renal substance as well. The third is that of Watson, in which the sutures pass through both the capsule and the renal substance, and in which the kidney *is* partly decorticated. The second is that of Edebohls, in which the kidney is freely decorticated and in which the *sutures pass through the capsule of the kidney only*. In all three operations the lumbar incision is usually closed tight without drainage.

FIG. 429



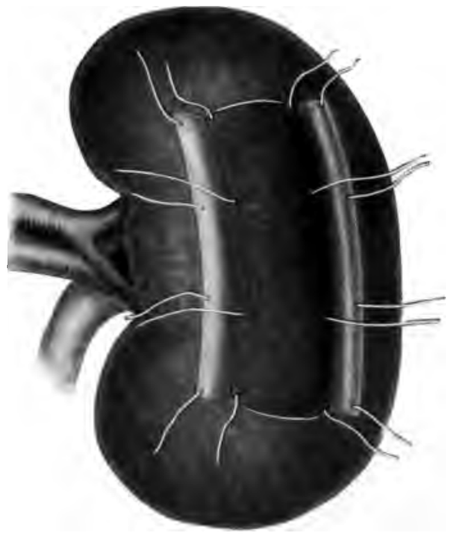
Manner in which sutures are placed in Morris' method of doing nephropexy.

Morris' Method.—Morris thus describes his manner of doing the operation:

"Three sutures are passed deeply into the posterior surface of the kidney, one nearer its upper and another nearer its lower end, and the third midway between the two, but nearer the hilum. Each suture is buried for a length of three-quarters of an inch within the renal substance, and penetrates about half an inch into the thickness of the organ. The

upper suture passes through the upper edge of the shortened adipose capsule, the fascia transversalis and the deeper layer of muscles, and is tied to them; the lower suture is similarly passed through and tied to the lower edges of the same cut structures; and the intermediate suture is passed through both edges of the divided adipose capsule, fascia, and muscles, and lashes all up together. The sutures are cut short and buried in the wound. A drain tube is frequently inserted down to the kidney, and the cut edges of the lumbar muscles and skin are brought together by silk sutures passed through all the different layers. The patient is kept in bed from four to five weeks" (see Fig. 429).

FIG. 430



Manner in which sutures are placed in Tuffier's method of doing nephropexy.

Tuffier's Method.[1]—The kidney is denuded of a part of its capsule upon the posterior surface, as seen in Fig. 430. The edges of the capsule are turned back on either side of the denuded area.

Three sutures are then passed from each of the two sides of the denuded area through the reflected capsule, thus making six threads altogether, three passing in one direction and the other three in the opposite one, penetrating the reflected leaf of the capsule on their respective sides, then traversing the kidney substance and taking up the turned back bit of the capsule in issuing upon the other side of the denuded area.

The ends of the sutures are passed through the muscle and fascia

[1] This method was inserted as a fourth one after the description of the other three operations had been placed in the text, hence the inconsistency of the text in which it is stated that three methods only are to be described.

layers of each side of the lumbar wound and tied, and the latter is closed without drainage.

The Method of Edebohls.—The patient is placed upon the abdomen across the air cushion, which is shown in Fig. 428.

Deliver the kidney onto the loin, together with its perirenal fat envelope. If the lumbar wound is too small to allow of this being readily done, slightly incise the outer border of the quadratus lumborum transversely to the direction of its fibers.

Remove the entire fat tissue from about the kidney.

FIG. 431

Edebohls' method of placing sutures in the operation of nephropexy.

Palpate the kidney and its pelvis and the upper end of the ureter. If there is a calculus found or other condition to be remedied it should be done at this time.

Make a small opening in the fibrous capsule near the lower end of the kidney. Through this pass a grooved director between the capsule and the kidney and slit the capsule upon the director, throughout its length, along the line of the convex border. The incision of the capsule should be carried over each end of the kidney.

Separate the capsule from the surface of the kidney on either side of this incision and detach it from the surface to about half-way between the convex border and the hilum on either side (Fig. 431).

Pass four suspension sutures through the fibrous capsule close to the junction of the reflected with the unreflected part of it. Two of the suspension sutures are placed on either side of the kidney capsule in this way; one on each side is placed near the upper and the other near the lower end of the kidney. The kidney substance is not penetrated anywhere by these stitches. The suture material is catgut, and a curved Hagedorn needle is used.

Replace the kidney in its proper position.

Pass the free ends of the posterior sutures—from within outward—through the muscular layer of the posterior edge of the lumbar incision, and the anterior ends of the stitches through the anterior edge of the renal capsule. These ends are not to be tied together. The upper strands emerge just below the lower border of the twelfth rib.

Close the muscle and fascia layers of the lumbar incision by from four to six interrupted sutures.

Gently draw the previously placed sutures tight outside the now closed deeper parts of the lumbar incision, thus bringing the denuded surface of the kidney against the quadratus lumborum, and tie the ends of each suture to their *mates*. The threads are then cut short and buried beneath the integument.

The skin wound is closed tight over them.

Watson's Method.[3]—After bringing the kidney out upon the loin, the sutures are passed as follows:

Two parallel stitches are passed, one on either side of the summit of the convex border of the kidney, entering the kidney at the junction of the middle and lower thirds of the organ, and, passing through the renal substance about a quarter of an inch below the surface, parallel with the long axis of the kidney, are brought out about an inch and a half below the top of the upper pole (Fig. 432).

These two stitches are usually all that are required, but if greater surety is desired for the fixation of the organ, two transverse sutures may also be employed.

Tie the lower ends of the two sutures together, and draw the loop thus formed down upon the surface of the kidney. Tie the upper ends of the sutures together in the same way.

Let the kidnev drop backward into the wound.

Having placed curved needles on each of the upper ends of the sutures, pass the needles through either edge of the lumbar incision and as near as possible to its upper end.

Push the kidney upward as far as the sutures in it will allow, and while it is in this position tie their upper ends together.

Thread the lower ends of the sutures upon two needles and pass them

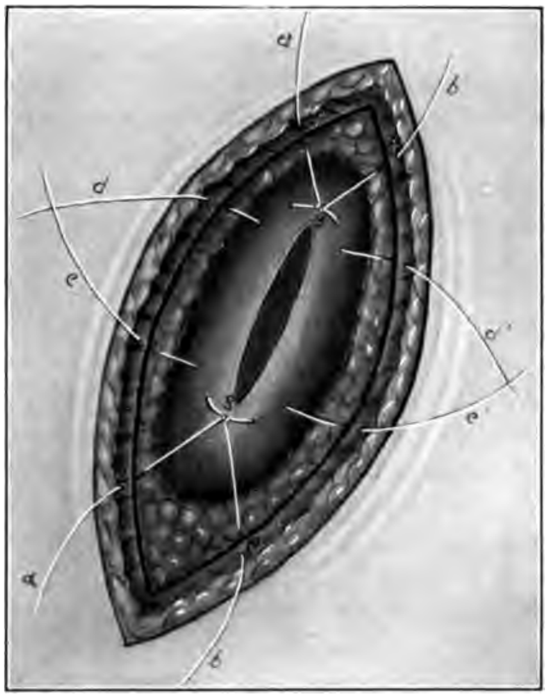
through the muscle and fascia layer of the lumbar wound on either side, at points which will not put too much tension upon the kidney, and tie them to each other.

Incise the fibrous capsule longitudinally from a point a little above the entrance of the sutures into the kidney above the upper pole.

Close the lumbar incision tight, without drainage (Fig. 432).

Examples of Objectionable Methods.—One thing has been clearly demonstrated with respect to operations for the relief of the conditions produced by abnormal mobility of the kidney, namely, that it is entirely

FIG. 432



Watson's method of placing sutures in the operation of nephropexy.

unnecessary to attach the organ to the rib, and also that complicated and prolonged operations are not required in order to obtain the best results. For which reasons such operations as those of Jennesco and of Vulliet are objectionable. If the condition of the kidney which is shown in Jennesco's article represents it correctly, it has the further and most objectionable feature of placing the kidney in an unnatural position.

The incision of Jennesco is that which is parallel with the lower border of the twelfth rib. The kidney, after being exposed, is brought upward and attached to the last rib by sutures which, according to the illustration,

bring the convex border of the organ into a position parallel with that rib and there maintain it, thus twisting it out of its natural position.

Vulliet's Method.—This method is even more objectionable, because of its needlessly complicated technique.

The fixation of the kidney to the inner surface of the loin is accomplished in this method by passing through it a strip of the tendon of the erector spinæ muscle of the patient, and bringing it out through the lumbar incision and back again through the *muscle layer* of the lumbar incision.

Mortality and Late Results of Nephropexy.—In 1088 cases collected from the literature by the writer the operative mortality was 1.4 per cent.

The immediate results, in all but a few cases, are excellent. The late results are difficult to judge. In estimating them, it must be remembered that many patients whose symptoms were, in fact, referable to general neurasthenia and not to the renal mobility have improperly been subjected to the operation. This contingent supplies the larger proportion of operative failures that are credited to nephropexy by those who see the patients subsequently.

If judged by the results in the cases in which the symptoms have been *correctly* ascribed to the abnormal mobility of the organ, the percentage of failure attending the operation is very small, probably not more than 3 per cent.

The writer has collected a series of 158 cases in which the operation was done by competent surgeons, and has analyzed them with reference to the late results. The analysis yields the following data:

Absolute cures	132
Great improvement	18
Failures	8
Total number of cases	158

This gives 83.5 per cent. of cures and about 5 per cent. of failures. The patients were under observation for periods of from one to twenty years after the operations were performed.

CLOSURE OF RENAL FISTULA.

Instruments and Position.—The same as for lumbar nephrotomy.

Operation.—Dissect out the mouth of the fistula, together with a small margin of the skin around it.

Pass a probe into the fistula and through the entire length of the tract.

Ligate the freed orifice of the fistula tightly around the probe.

Dissect the fistulous tract, together with its immediately surrounding tissue, from the structures about it, until the kidney surface has been reached. In doing this the tract of the fistula must not be opened. The probe will serve as a guide to the operator, and will enable him to avoid this accident.

Clear the surface of the kidney around the point of entrance of the fistula into it sufficiently to allow the placing of sutures in the manner described below. In order to reach the kidney and expose the requisite area of its surface it will be necessary to make an incision of greater or less extent on either side of the fistula, in most cases. When the kidney surface is close to the surface of the loin, as it sometimes is in the cases in which renal fistula exists, this incision may not be required.

Pass two catgut sutures in directions opposite to each other through the kidney substance, leaving them loose for the moment.

Make a circular cut extending a little into the substance of the kidney, around the renal orifice of the fistula and within the area included by the two sutures.

Withdraw the tip of the probe slightly outside the surface of the kidney and ligate the fistulous tract below this point and close to the surface of the organ.

Cut the tract across between the ligature and the kidney and remove it, together with the probe. Draw the two sutures tight.

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CHAPTER XXVIII.

THE URETERS.

ANATOMY OF THE URETERS.

THE ureters are the conduits which convey the urine from the kidneys to the bladder. They begin at the outlets of the renal pelves, pass downward in converging lines to the bladder, penetrate its outer covering about an inch and a quarter above the prostate, traverse its walls obliquely, and terminate in two slit-like orifices upon its inner surface, one at either end of the transverse elevation, called the interureteral bar, which defines the upper border of the trigone.

The ureters are from twelve to fourteen inches in length, and one-sixth to one-eighth of an inch in diameter. They are flattened antero-posteriorly.

They are not of uniform caliber throughout, having three points of narrowing in their course, namely, at about an inch and a half below the renal pelvis, at their point of crossing the iliac vessels, and in the part which lies within the bladder wall.

These points of narrowing are of practical importance, in that calculi are apt to be arrested by them in their descent from the kidneys.

The ureter is divided, for purposes of description, into an abdominal and a pelvic portion, which are above and below the pelvic brim, respectively.

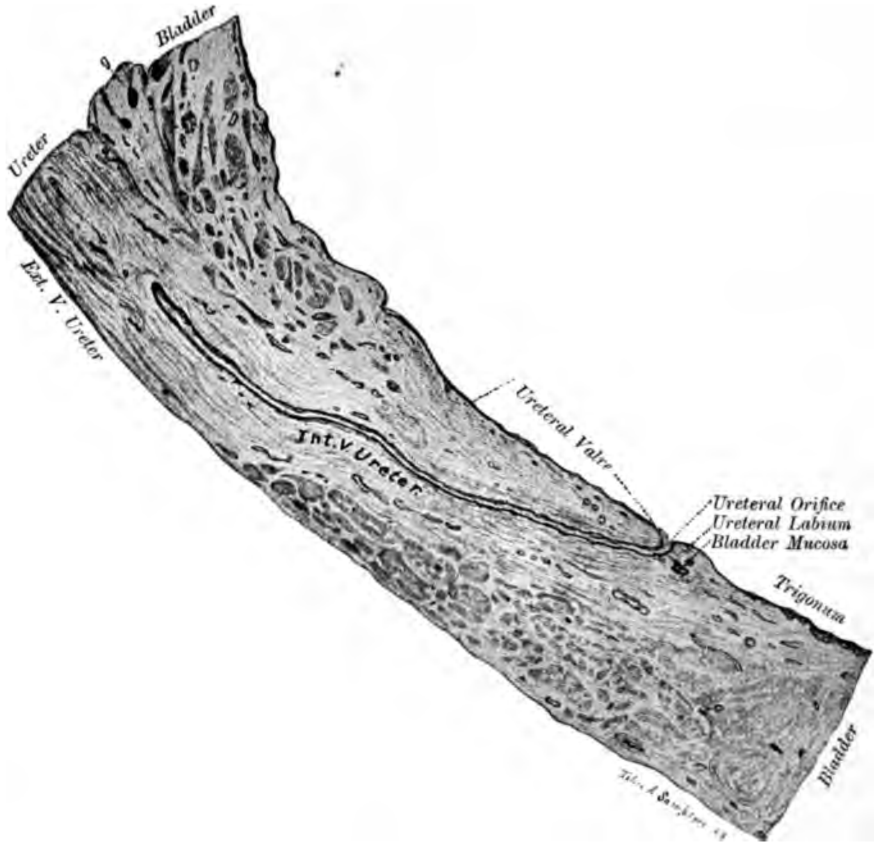
The abdominal portion corresponds to a line drawn from the junction of the middle and inner thirds of Poupart's ligament to the tip of the ninth rib. The point of crossing the iliac artery is at the intersection of a line drawn perpendicularly upward from the spine of the pubis, with a horizontal one passing from the anterior superior spine of the ilium on one side to its fellow on the other.

Structure.—The ureter is composed of an outer *fibrous*, a middle *muscular*, and an inner *mucous* coat. These are continuous, respectively, with the corresponding coats of the bladder below and with those of the renal pelvis above.

The muscular coat is extended in the bladder beyond the ureteral orifice on either side, and passes on each side of the trigone toward the neck of the bladder. Another set of its muscle fibers extends to and into

the vesical outlet, upon its posterior aspect, and is thought by some to be concerned in opening it to allow the urine to pass out of the bladder.

FIG. 433



Longitudinal section of the vesical portion of the ureter. Distended bladder. The ureteral orifice may be a slit with the labia close together, or an oval or even almost a round opening, and sometimes the lumen of the ureter extends below the orifice, forming a pouch. In other cases the labia may diverge, giving rise to an orifice having the form of an inverted V or U. In this instance the orifice had the form of a slit with the labia close together. As can be seen, the section intersected the long axis of the orifice at an angle, so that only the upper one-third of the orifice is seen, the lower two-thirds being obscured by the labium which is lateral to it. This labium is so cut that a part of the bladder mucosa is exposed, lining the floor of the orifice and the mesial surface of the labium, which has the appearance of gland-like space, and is marked "bladder mucosa" in the drawing. Note that the course of the ureter through the bladder is very oblique and that it apparently passes through the bladder as a distinct organ and that its mucosa becomes continuous with that of the bladder. Its mucosa is smooth and its lumen is flattened anteroposteriorly. One can see that intravesical pressure would force the ureteral valve against the posterior wall of the ureter, and thus close its lumen: *g* is a ganglion, *Ext. V. Ureter* is the extravesical portion, and *Int. V. Ureter* is the intravesical portion of the ureter. (Sampson.)

The muscle fibers extend into the lips of the vesical ureteral orifice, and serve to open it for the urine to pass through into the bladder.

The vesical end of the ureter is not provided with a true valve. Regurgitation of the urine through it from the bladder is prevented by the action of the muscles of the latter upon the part of the ureter which traverses the vesical wall, and by the oblique course of that portion of the canal through it (see Fig. 433).

The epithelial cells of the mucous membrane are arranged in superimposed layers.

The cells of the deeper ones are conical or oval, those of the superficial ones caudate or cuboidal.

Glandular Tissue.—Hamburger states that there is a more or less well-developed adenoid tissue beneath the epithelial lining of the ureter, in which a few lymph follicles exist. Wendt also has demonstrated the presence of mucous glands in the mucosa, especially at the upper end of the ureter.

Bloodvessels.—The arterial supply of the ureter comes from the spermatic artery, a branch of the renal artery—which also nourishes the pelvis of the kidney—the middle hemorrhoidal, the inferior vesical, and either the common iliac or hypogastric arteries. Of these various arterial branches the last named are the most important.

Lymphatics.—The ureter possesses lymph vessels, the afferent channels of which join together to form larger canals in the outer fibrous covering. They play a more or less important role, probably, in the transmission of infections from the bladder to the kidney. Their part in such processes is, however, but little understood.

Nerves.—The nerves of the upper part of the ureter are derived from the spermatic and renal plexuses of the sympathetic system; those of the lower part, from the hypogastric plexus.

Relations.—The upper end of the ureter is in direct relation with the renal pelvis, which is sometimes referred to as an expansion of the ureter. In its passage downward to the bladder it passes through the perirenal fat tissue; its posterior surface crosses the psoas magnus muscle obliquely. On the right side it lies close to the vena cava. The genitocrural nerve passes *beneath* it, and the spermatic vessels *above* it. At the brim of the pelvis it crosses the iliac bloodvessels. As it approaches the bladder it passes *under the vas deferens* and enters the viscus on its posterior aspect, close to the seminal vesicle, and about an inch and a quarter above the upper margin of the prostate.

Relations to the Peritoneum.—The ureter lies behind the peritoneum throughout its entire length; it is, however, so closely connected with it in its lower abdominal and pelvic portions, that in separating the perito-

neum from the abdominal parietes, in order to approach the ureter, the latter will be found attached to its under surface, and is to be sought for there.

In an exploratory operation through the lumbar incision the ureter can be made tense, and is thereby more easily discovered, by drawing the lower end of the kidney well upward and backward, and then palpapating the ureter as it descends. It will be found, under these circumstances, close to the posterior surface of the overlying peritoneum and not in contact with the iliac muscles and structures.

The last inch of the ureter before it reaches the bladder is not covered by peritoneum, because of the latter being reflected backward and away from it at this point. Owing to this fact, the last inch of the ureter outside the bladder can be operated upon without opening the peritoneal cavity.

The urine is discharged intermittently from the ureteral orifices into the bladder. That the muscular fibers with which the canal is provided favor the transmission of the urine from the renal pelvis to the bladder by the influence of peristaltic waves is believed to be an established fact. That they determine the occurrence of the intermittent flow is shown to be improbable, for the reason that its intermittent character is not influenced by the insertion of a ureteral catheter and the withdrawal of the urine through it.

Manner of Examining the Ureter.—The ureters can be palpated in the female through the vaginal wall on either side; less readily through the rectum, and they can sometimes be felt through a thin abdominal wall in either sex if they are the seat of a pathological condition which renders them hard or enlarges them markedly.

The other methods of examination are by means of the cystoscope, by the use of which the appearances of their vesical orifices can be observed, and by the employment of the ureteral catheter, by which calculi lodged in them and constrictions in their course can be detected. (These procedures are described in the chapters on Cystoscopy and Ureteral Catheterization and Operations on the Ureters.)

The *x*-ray examination in connection with the use of a ureteral catheter carrying a metal stylet is a valuable means by which to determine the course of the ureters and to discriminate between calculi lodged within them and osseous or other bodies which may be mistaken for calculi.

The insertion of a ureteral catheter may enable the examiner to palpate the ureter more readily through the vaginal or rectal walls, but its employment will generally make palpation superfluous, so that this fact has but little practical importance.

The examination of the ureter through lumbar or abdominal incisions has already been spoken of.

ABNORMALITIES OF THE URETERS.

(See Abnormalities of the Kidneys.)

INJURIES OF THE URETERS.

(See chapter on Subparietal Injuries of the Kidneys.)

DISEASES OF THE URETERS.

Ureteral Fistulæ.—Etiology.—Ureteral fistulæ are *congenital* or *acquired.* The congenital forms are rare and have already been discussed in connection with congenital malformations of the kidney in the chapter which deals with that subject.

The manner in which *acquired fistulæ* are produced is discussed in the chapter on Subparietal Injuries of the Kidney and Ureter.

The acquired fistulæ appear in the form of communicating openings between the ureter and vagina, ureterovaginal fistula; between the ureter and the uterus, uretero-uterine fistula; between the ureter and the bladder, ureterovesical fistula; between the ureter and the intestine, uretero-intestinal fistula; and if the orifice of the fistula opens upon the surface of the abdomen, uretero-abdominal fistula.

The order of their relative frequency of occurrence is suggested by the following table, taken from an article of Ferguson:[1]

	Cases.
Uretero-vaginal	60
Uretero-uterine	4
Uretero-abdominal	3
Total	67

Of these 67 fistulæ, 4 were congenital, 25 resulted from parturition (in 16 of them delivery was made by the forceps), 12 resulted from wounding of the ureter during the performance of vaginal hysterectomies, 2 from ulceration of the ureter produced by calculi, 1 from tuberculous ulceration, 2 from pelvic abscesses, 1 from pressure of a pessary, and 1 from violence.

Symptoms.—The essential feature of ureteral fistula is, of course, the discharge of urine from an opening communicating with the surface of the body or with one of the organs named above, and the ureter.

The character of the fluid discharged may be either clear urine, or urine and pus mixed, and there is sometimes more or less calculous material as well.

If the communicating opening with the ureter is free and the drainage from the kidney is freely maintained, there is far less likelihood of the kidney becoming infected—should it not already have been so at the time of the establishment of the fistula—than when the orifice of the fistula contracts.

The liability of ureteral fistula to contract is the most serious feature of the condition and the one which furnishes the strongest argument against the intentional establishment of such a fistula. (See section on the Bladder, chapter on Tumors of the Bladder.)

The symptoms connected with the fistula are such as arise from the renal conditions already present or induced by the failure of free drainage due to the contraction of the orifice of the fistula.

Prognosis.—Ureteral fistula seldom closes spontaneously. If the orifice of it can be prevented from contracting, the prognosis so far as life is concerned is good.

Treatment.—The treatment consists in restoring the continuity of the ureter, if this can be done, and if not, in arranging to make the patient comfortable, which is accomplished by having him wear an apparatus into which the urine drains and which at the same time keeps the wearer dry.

In the cases in which free drainage cannot be maintained, or in which the kidney becomes infected, nephrectomy should be done, if the other kidney is known to be functionally capable.

OBSTRUCTIVE CONDITIONS OF THE URETER.

(See chapters on HYDRONEPHROSIS and on RENAL CALCULUS.)

Valves.—Valves of the ureter may be either *congenital* or *acquired.* The congenital forms are rare (Fig. 434).

The acquired forms are seen in connection with hydronephrosis, with which condition they are usually associated. Morris ascribes their occurrence in these cases to the raising upward of the part of the ureter where it joins the renal pelvis, or a downward bagging of the renal pelvis, which is practically the same thing, and which takes place when the pelvis is dilated.

In one case reported by Morris, a portion of the distended renal pelvis projected in the form of a lip or valve at the outlet of the pelvis into the ureter.

Morris also refers to the occurrence of similar valve-like conditions in other parts of the ureter, and says that they have been produced in some instances by the ureter having become adherent at this point;

subsequently, a dilatation of the canal has been produced above the adherent point, and when this sac or dilated part for any reason becomes

FIG. 434

Congenital valves of the upper end of ureter, producing hydronephrosis. (Cunningham.)

empty, its relaxed walls immediatelv adjacent to the fixed part of the canal become invaginated into it in the form of a valve (Fig. 435).

Sampson holds that such valves are due to a rupture in the peri-ureteral fibrous sheath.

Kinks.—Kinks and bends of the ureter are due to abnormal mobility of the kidney, and may produce intermittent or permanent hydronephrosis. The latter condition, however, is not of very frequent occurrence in cases of movable kidney. (See chapter on Movable Kidney.) Kinks may also be caused by adhesions which involve the ureter.

Fig. 435

Acquired valves of the ureter. (After Ehrhardt and Garré.)

Stricture of the Ureter.—Stricture of the ureter appears in both *congenital* and *acquired* forms.

Congenital stricture occurs in the lower or in the upper end of the canal at the points at which the natural anatomical narrowings, called the isthmuses of the ureter, exist.

Acquired stricture of the ureter results from preceding inflammation, or from ulcerations due to infection, or to impacted calculi.

Diagnosis of Ureteral Obstructions.—The existence of hydronephrosis, in the absence of any condition of the bladder or urethra which prevents the free escape of urine from them, is presumptive evidence of the presence of an obstruction of one or another sort in the ureter.

The actual demonstration of the presence of such an obstruction can only be made by the ureteral catheter, or by an *x*-ray photograph, or by both. The former method of detecting obstructions in the ureter is a satisfactory one when it can be put in practice; the latter is of service only in order to detect the presence of stone impacted in the course of the ureter or obstructing the outlet to the renal pelvis.

In cases of stricture of the ureter, there is no flow of urine through the ureteral catheter until it has passed the constricted point, when there comes a sudden and more or less copious and continuous discharge of it

through the instrument. The same phenomenon is observed in cases of obstruction of the ureter caused by pressure upon it from without by tumors, constricting bands, etc. When calculus is the cause of the obstruction, the passage of the catheter is arrested by a solid body, which, in most instances, does not, however, prevent the further advance of the instrument. The "wax-tipped" ureteral catheter is of service in determining whether or not the obstruction is due to a calculus. The hard stone, if it be present, leaves an impression on the soft wax-tip of the ureteral catheter which is not produced by other conditions (Figs. 436 and 437).

FIG. 436

Scratches made by introducing wax-tipped catheter a short distance into the ureter. Its introduction was marked by the immediate escape of 8 c.c. of urine, showing obstruction, and on its withdrawal the scratches were seen. The ureteral orifice, rendered non-sensitive by the injection of a 1 per cent. cocaine solution into the tissues through the vaginal wall, was then dilated with ureteral metal catheters, when the stone escaped. The entire manipulations were conducted through a vesical speculum. (Kelly.)

FIG. 437

These scratch marks were made by passing the wax-tipped catheter down the ureter through the pelvis of the opened kidney in search of a lost stone. The stone was located in the lower end of the ureter, and removed by the vagina. (Kelly.)

In cases in which there is doubt as to the nature of certain bodies which lie near the course of the ureter, and which might be mistaken for calculi, the x-ray picture will show that they are extra-ureteral, if the picture is taken with a ureteral catheter and a metal stylet lying in the ureteral canal. The stylet stands out clearly in the photograph, and thus serves to define the course of the ureteral canal and its position with reference to the bodies of which we have spoken.

The erroneous impression of having the ureteral catheter arrested by

a stricture may be given by its tip having become engaged in a fold of the mucous membrane.

Treatment.—Ureteral stricture may be treated by: (1) Dilatation (*a*) at repeated sittings; (*b*) continuous. (2) By longitudinal incision and transverse suture of the wound, as in the Heinecke-Mikulicz method of treating constriction of the pylorus. (3) By resection of the constricted portion of the ureter and joining its severed ends together, or by implanting the end of the lower segment into the renal pelvis.

Dilatation.—Dilatation is only applicable to strictures which permit the passage of the ureteral bougie. The method of treatment is advocated in such cases as these by Kelly and some others. Kelly speaks with regard to it as follows: "This is the best, safest, and the easiest mode of direct treatment for all strictures located low down in the ureter and due to chronic inflammation, except in tuberculous ureteritis; here, too, temporary relief will sometimes follow moderate dilatation, and the evacuation of the accumulation, if practised with a regular washing out of the tract above."

Continuous dilatation has been applied to ureteral stricture by maintaining a ureteral catheter in the canal for considerable periods of time continuously. It is not a method of treatment which greatly commends itself.

It is to be remembered that hydronephrosis is a constant accompaniment of the ureteral stenosis and that treatment of the stricture by dilatation may not afford any relief to the hydronephrotic kidney. The latter condition may, in a number of instances, be perpetuated by other conditions of an obstructive character, higher up in the course of the ureter than the stricture, namely, the valve-like formation produced in cases of hydronephrosis by the change of position of the upper ureteral orifice with reference to the renal pelvis.

The renal condition, as well as the ureteral one, can be directly attacked and more efficiently dealt with through a lumbar incision and exposure of the kidney and the upper end of the ureter.

The treatment of kinks or twists of the ureter consists in correction of the malposition or abnormal mobility of the kidney, upon which their existence depends. This is done by the operation of nephropexy.

Valves require plastic operations upon the upper end of the ureter or upon the renal pelvis for their correction. (See chapter on Movable Kidney.)

Obstruction of the ureteral canal by an aberrant branch of the renal artery will probably never be recognized previous to the exposure of the kidney by an exploratory incision, so that it will have to be dealt with in the course of an operation for the relief of hydronephrosis or pyonephrosis.

When discovered in this way, the treatment will consist in the double ligature of the aberrant bloodvessel and resection of the part of it which is causing the pressure from the ureter.

Prolapse of the Ureter.—Prolapse of the ureter, which is a rare affection, is most often seen in children, and more frequently in the female than in the male. It is usually congenital, but may be produced by stenosis of the lower orifice of the ureter. Blumer[2] collected 13 cases from the literature, 10 of which he regarded as being congenital. Five of the patients died in early childhood from septic infection of the urinary tract.

Etiology.—The condition is probably due to a combination of causes. Boström[2] has pointed out that in the congenital cases the ureter enters the bladder less obliquely than is normally the case, and that thereby the support of the bladder wall which ordinarily is present is in these instances lessened. Bruckhard[2] calls attention to the fact that there is an actual deficiency of the muscle tissue of the bladder wall in these cases, which results in a loss of the support which is normally present.

Stenosis of the ureteral orifice is generally a causal factor in the production of the condition.

The increased pressure of the urine against the lower end of the ureter, and lack of support of the vesical end of the canal causes the ureteral mucosa to become prolapsed into the bladder. The ureteral opening is situated at the most prominent point of this tumor.

Kelly[3] states that the prolapsed portion of the ureter may present at the external orifice of the female urethra and may then be mistaken for an eversion of the latter canal.

Blumer[2] mentions the case of a man who had an acquired prolapse of the ureter, which occurred in the course of an acute cystitis five years before the patient's death.

Sir Thomas Smith[4] records the case of a patient who had symptoms of urinary obstruction, and both of whose ureters were prolapsed into the bladder. A calculus occupied the prolapsed portion of the canal of the right side.

Beach records a case in which there were three ureters which united into a single canal near the bladder and entered that organ in an abnormal position, and in which a prolapse of the ureter existed.

Symptoms and Diagnosis.—Infection of the upper urinary tract on the affected side is of common occurrence, and the symptoms are those which ordinarily appear in connection with this condition. Morris states that dysuria is the most common symptom present, and attributes it to the obstruction of the vesical orifice by the tumor as the bladder contracts. The diagnosis is made by cystoscopic examination.

Treatment.—The treatment consists in isolation of the ureter outside of the bladder and its transplantation into that organ. (See chapter on Technique of Operations upon the Ureter.)

Cysts of the Lower End of the Ureter.—Fenwick[5] records several cases in which this condition existed, one of them being that which is reported by Eppinger, who describes it as having been connected with the lower end of the ureter as it entered the wall of the bladder in the usual situation, but which then extended in the direction of the ejaculatory duct, with which it communicated. The ureter throughout this part of its extent formed a cyst with a thin transparent wall, which was covered in front by mucous membrane and behind by the muscular coat of the bladder.

In some instances the cyst appears as an intravesical protrusion, closely resembling the prolapsed ureter. Fenwick thus describes the manner in which the condition is produced in those cases in which, as frequently happens, the orifice of the ureter in the bladder is exceedingly small.

"The force which is exerted by the urine is at first expended upon that section of the ureter which traverses the vesical muscle, and especially upon the thin and lax mucous membrane covered orifice. This part gradually acquires the form of a bottle, the base of which is at the ureteric orifice. Gradually the mucous membrane is thrust into the bladder in the form of a globular cyst. Its appearance varies according to the thinness of the wall. It is distinguished from prolapse by its shape. A section of this cyst-like structure shows it to be lined inside by the mucous membrane of the ureter, while its external layer is composed of the lining of the bladder."

Fenwick states that, with two exceptions, all the cases recorded have been unilateral. He calls attention to the frequent occurrence of double ureter on the same side as the cyst—in 9 out of 15 cases, and also says that the upper third of the kidney from which the ureter having the cyst at its further end proceeds is atrophied, while the lower end of the organ, in which the other ureter originates, is normal.

Freyer[6] mistook the condition for intravesical tumor in one instance, and performed a suprapubic cystotomy, removing a tumor, which was the size of a walnut, and which was then seen to be a cyst of the lower end of the ureter.

Ureteritis Cystica Chronica.—Definition.—The condition is one in which the interior lining of the ureter is the seat of numerous small cysts.

Frequency.—The affection is very rare. Lubarach[7] found but 1 case in over 3000 autopsies. Bond-Stow[8] has seen one example in the course of several hundred autopsies, and was able to collect but fifty others from the literature.

FIG. 438

Cystic diseases of the ureter. (Garré and Ehrhardt.)

Etiology.—The nature of the etiological factors of the condition is not clear and different views are held with regard to it, thus: Eve,[9] Clarke,[10] Bland-Sutton,[11] Kahlden,[12] and Silcock[13] have drawn attention to certain peculiar round or ovoid bodies, which they maintain, are constantly found within the fluid contents of the cysts, which they interpret as being a protozoa, and which have never been found in or between the epithelial cells lining the interior of these cysts.

The opinions of Lubarach, Marckwald, Aschuff, v. Brunn, and the experimental studies of Giani, on the other hand, indicate that the cysts may be of inflammatory origin.

Virchow and Litten believe that the cysts are true retention cysts occurring in the small glands of the ureter described by Wendt and Hamburger. (See Anatomy of the Ureter.)

Morris[14] gives an illustration of the condition, the cause of which he believes to be coccidia.

Pathology.—The inner surface of the ureters is more or less thickly studded with yellowish round cysts the size of millet seeds or slightly larger. Their fluid contents consists of epithelial cells, red blood corpuscles, leukocytes, fragments of cells and a small amount of viscid fluid (Fig. 438). (From Garré and Ehrhardt.)

Giani, in his experimental studies, found a body in the cysts which stains deeply with hematin, and which corresponds to the description of the protozoon referred to above, but which he considers to be a cell nucleus. He created the cystic condition of the ureter experimentally by producing a chronic cystitis by the introduction into the bladder of gelatin capsules containing a pure culture of the tubercle bacillus. The experiments which were undertaken with a view to the production of vesical tuberculosis, and did not have for their aim the artificial creation of the cystic disease of the ureter, showed, incidentally, that the latter condition

may, at any rate, be produced in the course of vesical inflammation, though it may or may not be due to the latter.

In Bond-Stow's case there was a duplication of the ureters of both sides and chronic Bright's disease of both kidneys. Bond-Stow raises the question whether or not the ureteral malformation has any significance with respect to the concomitant cystic disease, but his is the only instance recorded in which such malformation has been present. In a number of the others, however, nephritis or cystitis were present.

In Kahlden's case there was a carcinoma of the bladder.

Diagnosis.—It is highly improbable that the condition will be diagnosticated during life, though it is possible that the discovery in the urine, drawn by ureteral catheter, of the cyst's contents, which has escaped because of their being ruptured by the instrument, might possibly lead to the detection of the disease.

Ureteritis.—Etiology.—Inflammation of the ureter originates in: descending infection from the kidney, or in ascending infection from the bladder; in direct infection of the ureter by the passage of instruments into it; in infection entering through the open end of a fistulous ureteral tract; and, finally, in extension of inflammation from already infected neighboring parts, *e. g.*, the peritoneum or the perirenal tissue.

As in the case of the bladder, infection of the ureter is invited by hyperemia of its mucous membrane, by loss of contractility of its muscular wall, such as occurs in obstructive conditions of the canal; and also by trauma, one form of which is the injury inflicted by an impacted calculus.

Symptoms and Diagnosis.—There are few, if any, characteristic signs by which the condition can be recognized. The symptoms produced by inflammation of the ureter are masked by those which arise in connection with the infections of the bladder or other part of the tract with which it is invariably associated, and of which it is but a part.

Tenderness on pressure over the ureter is, practically speaking, the only evidence which is in any sense distinctive. In the cases in which there is marked dilatation of the ureter it is sometimes palpable.

Garceau has called attention to the presence in the urine of clumps of squamous epithelial cells without associated pus, and considers them as suggestive of the existence of ureteritis. The cystoscope is of decided aid in making the diagnosis.

The vesical orifice of the ureter usually shows more or less well-marked changes, which are recognizable by the cystoscope, but this is not invariable.

Treatment.—The treatment is to be directed chiefly to the condition with which the inflammation of the ureter is associated; that is to say, to the lesions of the bladder or of the kidney.

Kelly has employed irrigations of the ureteral canal with mild antiseptics. Morris counsels against the use of all local measures because of the liability to augment the already existing inflammation, and we entirely share his view.

Fig. 439

Secondary melanotic sarcoma of the ureter. (Warren Museum.)

Neoplasms of the Ureter.—Tumors of the ureter are reported by Albarran and others. Albarran collected 32 cases. They are all comprised in the group of epithelial growths. Benign papilloma, and carcinoma have been recorded.

The case from which we have taken the accompanying illustration (Fig. 439) was one of melanotic sarcoma, the condition being secondarily manifested in the ureter in the form of the tumor which is shown in the figure.

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CHAPTER XXIX.

OPERATIONS ON THE URETERS.

Nomenclature.—Confusion is likely to arise with regard to operations upon the ureter, owing to the nomenclature in which they have been enveloped, and the habit of creating needlessly complicated names for certain procedures, as well as the application of several different names to the same operation, or the same name to different ones. So far as possible we desire to make this part of the subject clear, and therefore preface the chapter with a list of the operations given below and the explanation of their nature.

In a general way, the purposes of the various procedures are: To restore the continuity of the ureter; to implant the end of the upper part of a ureter which has been divided, into neighboring organs or structures, or onto the surface of the body, in the latter case for the purpose of creating a fistula, and in the former ones for the purpose of diverting the urinary secretion from its natural channel, or because of being obliged to implant the end of a ureter which it was necessary to divide in the course of an intra-abdominal operation; to restore the caliber of the ureteral canal where it has been narrowed by stricture; to correct an obstruction in the ureter due to a faulty position of its upper end in the renal pelvis; to remove a calculus from the ureter; to remove a part or the whole of the ureter.

The operations by which it is sought to accomplish these various objects are as follows:

1. Uretero-ureteral anastomosis or the joining of the two ends of a ureter which has been divided. This is carried out in several different ways, viz., (*a*) by end-to-end anastomosis; (*b*) by oblique end-to-end anastomosis; (*c*) by invagination of one end of the cut ureter into the canal of the other part of it; (*d*) by lateral anastomosis.

2. Pyelo-ureterotresis (also called ureteropyeloneostomy, and again pyelo-ureteroplasty). The implantation of the end of the ureter which has a faulty position with reference to the renal pelvis, into another place in that structure, with the object of doing away with an obstruction which is due to the faulty ureteropelvic junction.

3. Ureterovesical anastomosis (also called cysto-ureterotresis, cysto-ureteroneostomy, and cysto-ureteroplasty). The implantation of the divided end of the ureter into the bladder for the purpose of conveying

the urinary secretion from the kidney into the bladder through an artificial ureteral orifice placed in some part of the organ other than its natural one.

4. Dermato-ureterotresis. Implantation of the end of a divided ureter on the surface of the body.

5. Entero-ureteral anastomosis; also called entero-ureteroplasty, entero-ureterotresis, and, when made with the rectum, procto-ureterotresis (or plasty) or recto-ureterotresis (or plasty).

6. Ureteroplasty and pyelo-ureteroplasty. The operation for stricture of the ureter, which consists in longitudinal incision and transverse suture of the cut (after the manner of the Heinecke-Mikulicz pyloroplastic operation for benign stricture of the pylorus), and having for its object to increase the size of the ureteral canal at the strictured point. The second of the two terms is applied to the operation when it involves an extension of the longitudinal incision into the renal pelvis.

7. Ureterotomy. Longitudinal incision of the ureter; and, when done for the purpose of removing a calculus, called uretero-lithotomy.

8. Partial or total resection of the ureter or partial and total ureterectomy.

9. Grafting or plastic operations accomplished by grafts taken from the bladder, from the skin, and from neighboring connective tissue.

The list of names is already lamentably long and confusing, yet it does not include all those which have been coined by the writers upon this subject. We are unwilling, however, to follow them farther into the maze, and suggest that the student will do better to study and memorize the objects for which the operations are undertaken rather than to endeavor to fill his mind with the needlessly complicated and multiplied names created by the writers referred to.

General Considerations.—Exposure of the Ureter (Transperitoneally).—The abdomen having been opened, the ureter is reached and exposed by dividing the peritoneum overlying it by a longitudinal incision through the outer leaf of the mesocolon, if the upper part of the canal is to be approached; and through the peritoneum, downward from the pelvic brim, if it is the lower segment of the ureter that is sought.

The ureter can usually be felt by passing the finger tips to and fro over the peritoneum in a transverse direction, and it is most readily detected at the point at which it crosses the pelvic brim. The part of the canal to be exposed will be determined by the site of the pathological process in each case.

Exposure of the Ureter (Extraperitoneally).—For this purpose we prefer the paraperitoneal incision employed for extraperitoneal exposure of the kidney, and which is made about one inch outside of the linea semi-

lunaris and parallel to it, or else the oblique incision, which extends from the tip of the eleventh rib downward to the midpoint of Poupart's ligament. In either case the structures will be divided *to but not through* the parietal peritoneum. The latter is to be stripped from the inner surface of the abdominal wall in an outward direction until its reflection from it is passed and the hand of the operator has thus gained access to the posterior surface of this leaf of the peritoneum, to which, it is to be remembered, the lower segment of the ureter will be found attached. If this leaf of the peritoneum is drawn well upward in such a way as to put the ureter on the stretch, its detection is facilitated, for it then may be felt as a cord-like body running upward and downward upon the posterior surface of the detached peritoneum.

Besides the avenues of approach just described, there are others which supplement them in facilitating the approach to the lower or pelvic segment of the ureter. These are: by employing an inguinal incision alone, and by using the road employed in the operation of prostatectomy, viz., the inverted Y or the crescentic prerectal transverse cut, which are described in the chapter on the Technique of Operations on the Prostate.

The latter is a very satisfactory manner of approaching the lower portion of the ureter, especially if it is combined with a free inguinal incision parallel with Poupart's ligament and stripping upward of the peritoneum. By these combined steps the lower part of the bladder, the seminal vesicles, the posterior surface of the bladder as far as the tops of the vesicles, and the lower end of the ureter are exposed and made accessible to operative manipulation.

It may be stated as a general principle that, when possible, the ureter should be exposed and operated upon extraperitoneally, and by whichever of the above-mentioned extraperitoneal methods of approach is the more suitable for the purpose in view in any given case.

Suture Material.—Silk sutures are preferred by most operators to other materials for ureteral operations we prefer soluble material.

Drainage.—When forced to operate intraperitoneally, the part of the ureter operated upon should be surrounded by a protective tissue (peritoneum when it is available for the purpose), and drainage should be provided through the loin and the peritoneal cavity shut off from the ureteral wound.

URETERO-URETERAL ANASTOMOSES.

End-to-End Anastomosis.—Preparation of the patient is the same as that directed for operations upon the kidney at the beginning of the chapter on Kidney Operations.

Position of Patient (for transperitoneal exposure of the ureter).—Dorsal position, with the abdomen slightly arched forward by means of folded sheets placed beneath the small of the patient's back.

Surface Landmarks.—The same as for the paraperitoneal nephrectomy. (See chapter on Technique of Operations upon the Kidney.)

Instruments.—The same as for transperitoneal nephrectomy, and, in addition, two pairs of fine-toothed forceps, a blunt hook, and fine, curved needles threaded with silk; also intestinal needles and sutures, and a ureteral catheter.

Incision.—In the majority of the cases the incision will already be made, inasmuch as the uretero-ureteral anastomosis is called for by the accidental or necessary division of a ureter in the course of an abdominal operation, and the incision will have been determined by the nature of the operation for which it was originally made. When undertaken for the purpose of making the anastomosis, the abdominal incision is best begun by a comparatively limited cut, which can be extended upward or downward according to circumstances, if it should be necessary to do this.

Poggi's Operation.[1]—Poggi's operation consists in cutting the upper end of the divided ureter obliquely across, dilating the lower end, and drawing the former into the latter and attaching it there by a single suture.

Mayo Robson incises, instead of dilating the lower end of the divided ureter, passes the obliquely cut upper end into it, fixing it in position there by a single suture, and then closing the longitudinal incision in the lower end of the duct by interrupted Lembert sutures, and placing others upon the margin of the lower end and the wall of the upper end as an extra precaution.

Oblique End-to-End Anastomosis (Fig. 440).—Bovée modified the operation still farther by dividing both ends of the cut ureter obliquely, bringing them together and uniting their edges without invagination.

Van Hook's Operation (Fig. 441).—By invagination of the upper end of the divided ureter into the side of the canal near the divided end of the lower part, and its retention there by one suture, the opening in the side of the part of the ureter below the other divided end being closed around the upper invaginated end by a continuous suture, and the lower cut end being ligated. The upper or invaginated end is incised longitudinally from its cut edge for one-quarter of an inch upward from its margin. Keyes quotes Van Hook's description of the manner of joining the two ends thus: "Pass two very small cambric needles armed with one thread of sterilized catgut through the wall of the upper end of the ureter, one-eighth of an inch from the extremity, from within outward, the needles

being from one-sixteenth to one-eighth of an inch apart, and equidistant from the end of the duct. These needles are now carried through the

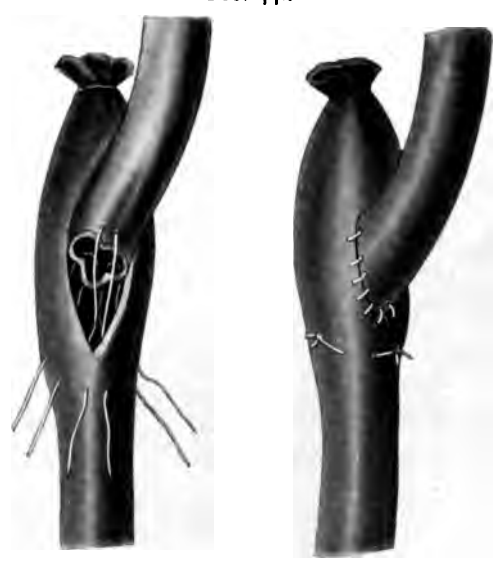
Fig. 440

Bovée's operation.

Fig. 441

Van Hook's operation.

Fig. 442



Emmet's operation.

slit in the side of the lower end of the ureter into and down the tube for one-half inch, where they are pushed through the wall of the duct side by side."

Traction on the ends is made and the upper end of the cut ureter is thereby drawn into the longitudinal slit in the other part of it. The two ends of the suture are now tied together, and the invaginated part of the duct is thereby fixed in place.

The site of the incision is enveloped with peritoneum, which is stitched around that part of the tube.

Emmet's Operation.—Emmet employs three sutures instead of one to invaginate the upper into the other part of the canal, and a continuous suture to attach the opening in the lower end of the ureter to the sides of the invaginated portion of the other end.

Continuous drainage of the bladder for one week, in order to lessen interureteral pressure, is advised by some surgeons. It is to be remembered, however, that this has the disadvantage of incurring the risk of vesical infection.

Drainage should be gradually withdrawn after the first thirty-six hours, and if there is no leakage, it should be wholly withdrawn at the end of the third day.

Comment.—Of the three ways of joining the severed ends of the duct, that of Van Hook is the easiest of performance. So far as can be determined by the few cases that are available for the purpose, there is little or nothing to choose between the methods with respect to the results, which appear to be about the same.

PYELO-URETEROTRESIS.

The object of this operation is to establish a free flow of urine into the ureter from the renal pelvis. It is employed in cases of hydronephrosis in which distention of the renal pelvis has produced a displacement of the ureteral orifice, or a valve-like condition at that point, which prevents the free escape of urine from the renal pelvis.

Preparation of patient and instruments are the same as for the other operations, which have already been described.

Position of the Patient.—The same as for lumbar nephrectomy.

Incision.—The oblique incision parallel with the outer border of the quadratus lumborum, or the incision parallel with the lower border of the twelfth rib. Before doing the operation upon the ureter and renal pelvis, the operator should make sure that the condition cannot be corrected by nephropexy, which should be done if such is the case.

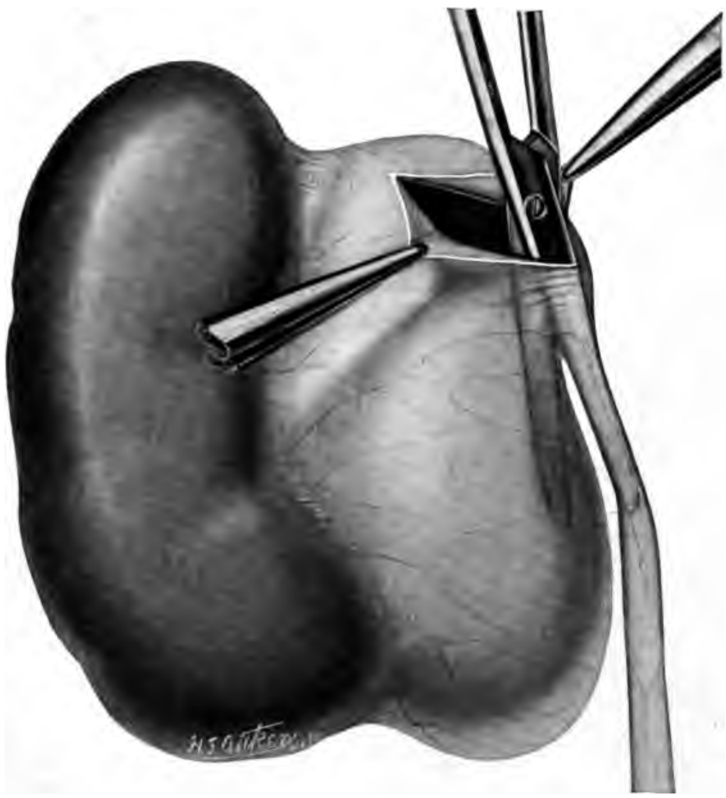
Operation.—The kidney and upper end of the ureter are exposed in the same manner as that employed in doing a lumbar operation upon the kidney. (See chapter on the Technique of Operations on the Kidney.)

Having exposed the kidney and renal pelvis, free the latter from its surrounding structures; clear the upper end of the ureter in like manner, and bring it up into the wound.

With a trocar withdraw the urine from the renal pelvis and kidney, if they are distended with urine. The trocar should be entered through the posterior surface of the renal pelvis near the ureteral orifice.

The tube of the trocar may be used as a guide, by entering it into the ureteral orifice, and incising the renal pelvis upon the instrument. The incision should be about half an inch long and in the direction of the outlet of the renal pelvis.

FIG. 443



Manner of lowering the ureteral outlet of the distended renal pelvis. (After Morris.)

The incision, if it is in the lowest part of the sac formed by the distended pelvis, should be extended into the upper end of the ureter and then closed by interrupted catgut sutures, making the ureteral outlet continuous with the lowest portion of the previously dilated sac (Figs. 443 and 444).

In some cases it will be impossible to find the ureteral outlet by exploration through the renal pelvis or cortex of the kidney, in others it will

be impossible to bring the ureter into communication with the most dependent portion of the sac except by dividing it below the renal pelvis and then reimplanting the cut end into the lowest part of the sac. This implantation is best accomplished by catching the end of the divided ureter in delicate forceps, placing a suture in one side of it, and by passing the other end of the suture through the incision made in the most dependent part of the renal pelvis and out through another small opening made higher up in it, in order to allow the stitch to be brought out of the

FIG. 444

Manner of closing the incision of the ureter and pelvis. (After Morris.)

pelvis again. The position of the ureter in which it is desired to fix it to the lower opening in the renal pelvis can be maintained by exercising traction upon the thread which has been passed through the other opening until sutures uniting the outer surface of the ureter with the edges of the lower incision in the renal pelvis can be placed, after which the first suture which has been used to guide the ureter into place may be cut off and that incision closed.

The end of the upper part of the ureter should be ligated close to the renal pelvis.

The end of the implanted ureter should be longitudinally incised, or cut across diagonally, to insure freedom from contraction subsequently.

NEPHROPEXY.

(See chapter on the TECHNIQUE OF OPERATIONS ON THE KIDNEY.)

URETEROVESICAL ANASTOMOSIS.

This operation is most frequently done because of the accidental severing of the ureter or the necessary resection of a portion of it in the course of the performance of intra-abdominal operations. The effort should be to implant the injured ureter into the bladder in a position as near as possible to the natural one of the ureteral orifice.

The incision will have already been made in performing the original operation, and its position and character will be determined by the nature of that operation.

This is the operation of choice in cases of abnormally placed fistulous orifices of the lower end of the duct and in all other ureteral fistulæ in which the distance of the opening is not too far away from the bladder to permit the anastomosis to be made.

Poggi[2] is said to have originated the operation.

Paoli and Busachi[3] confirmed Poggi's experimental work. Novaro[4] is credited with having been the first to perform the operation upon the human subject.

Bazy and Tuffier were among the first to perform the operation.

Novaro's Operation.—Position of Patient.—*Trendelenburg Posture.*—If the ureter has been divided in the course of an abdominal operation, the end to be implanted will already be free. If the operation is being done to correct a congenitally abnormal lower termination of the ureter, this end of the canal must be freed from its unnatural site, as the first step in the operation.

The ureter having been isolated, and its end incised slightly in a longitudinal direction, in order to enlarge its caliber, make an incision one and a half centimeters long, through the wall of the bladder at whatever point in it is most convenient for the purpose, using the tip of a sound, previously passed into the bladder through the urethra, as a guide.

Pass the cut end of the upper segment of the ureter through the vesical incision and attach the duct in this position by several interrupted sutures passed through the walls of the bladder and ureter at the level of the external edge of the incision in the former. Close the remainder of the

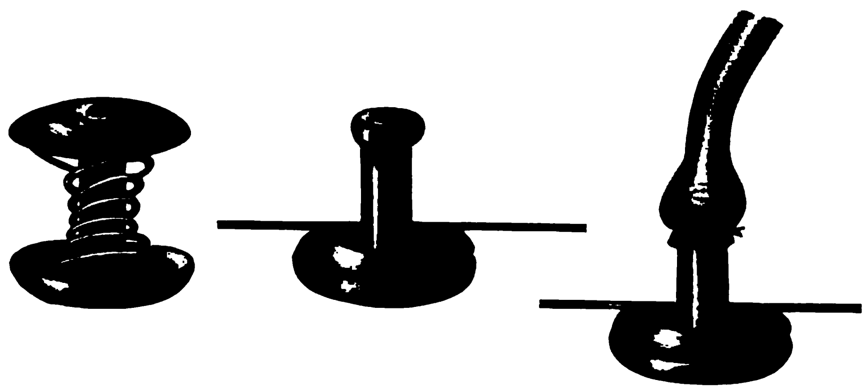
vesical incision by other sutures. Close the incision in the overlying peritoneum.

Drainage may be supplied retroperitoneally, before taking the step last mentioned, by leading a strip of gauze from the site of the implanted ureter, beneath the peritoneum, into the retroperitoneal space and out through the loin or inguinal region. This may be accomplished by stripping up the peritoneum between the site of the anastomosis and either of the points of exit of the drainage wick mentioned above.

Bazy approached the ureter retroperitoneally, and other operators have followed his example.

Sampson[5] exposed the right ureter extraperitoneally through a low McBurney incision under cocaine anesthesia, resected a part of it, and implanted the proximal end into the bladder. He repeated the operation upon the left ureter at a later date. Sampson emphasized the importance

FIG. 445



Boari's button.

of passing the end of the ureter into the bladder in such a way that it shall project beyond its inner surface, which he believes prevents the reflux of urine from the bladder into it.

Witzel[6] overcame the difficulty presented by too short a length of the ureter by displacing the bladder to the side of the iliac fossa and attaching it there. This shortened the distance separating the ureter from the bladder sufficiently to enable him to effect the junction of the one with the other. In this instance the end of the ureter was attached to the vesical mucosa by interrupted catgut sutures, as well as by sutures passed through the walls of the ureter and bladder externally to the latter.

Boari's Button[7] (Figs. 445 and 446).—This device is similar to the Murphy button. Its detail is shown in the accompanying illustration.

The contrivance is also used in the same manner as the Murphy button. The button sloughs off and falls into the interior of the bladder.

It can be extracted through the dilated female urethra, but cystotomy is required in order to remove it from the bladder of the male.

Some operators have passed a small soft-rubber catheter into the ureter and led it through the bladder and out of the urethra of the female patient, allowing it to remain a short time for the purpose of drainage of

FIG. 446

Boari's button in situ.

the ureter in a more direct manner and to thus relieve the pressure within the canal of the duct during the earlier period of healing.

It is of special importance to place the sutures in such a way as to overcome, as far as possible, the tendency to constriction of the newly made orifice.

In closing the peritoneum about the site of the anastomosis, care should be taken not to draw it too closely about the duct, else compression of its canal may result.

Comment.—Bovée[8] records 80 operations for implantation of the ureter into the bladder; 37 of these were done on account of accidental wounding of the duct in the course of intra-abdominal operations; 15 of this number were done by the intraperitoneal route, and at the time of the injury. There were but 2 failures and 1 death.

URETERORECTAL OR INTESTINAL ANASTOMOSIS.

The object of this operation is to divert the urinary secretion from its natural channel and lead it into the rectum or some adjacent part of the intestine. It has been employed more especially in cases of ectopia vesicæ. It is performed in a variety of different ways. There has been a great deal of experimental work done with reference to it, and a number of operations have been performed upon the human subject, but with the exception of Maydl's operation the results have been such as to practically lead to the abandonment of this method of diverting the urine into a new course. For this reason we do not think it worth while to recite the various procedures which have been contrived and which are chiefly interesting because of their ingenuity rather than for any practical value they possess. It may be said of one and all of them that they had better be abandoned and one of the other channels for the same purpose substituted in their stead. This is because of the very large proportion of the cases which prove fatal, either as the immediate result of the operation or because of the renal lesions which are produced later by ascending infection from the intestinal tract.

The reason for the exceptionally favorable results of Maydl's operation is to be found in the fact that in this procedure the part of the bladder immediately adjacent to the vesico-ureteral orifices is transplanted into the rectum, together with the ureteral terminations, and ascending infection to the kidneys becomes less probable in consequence, because of the protection afforded by the preservation of the natural relations.

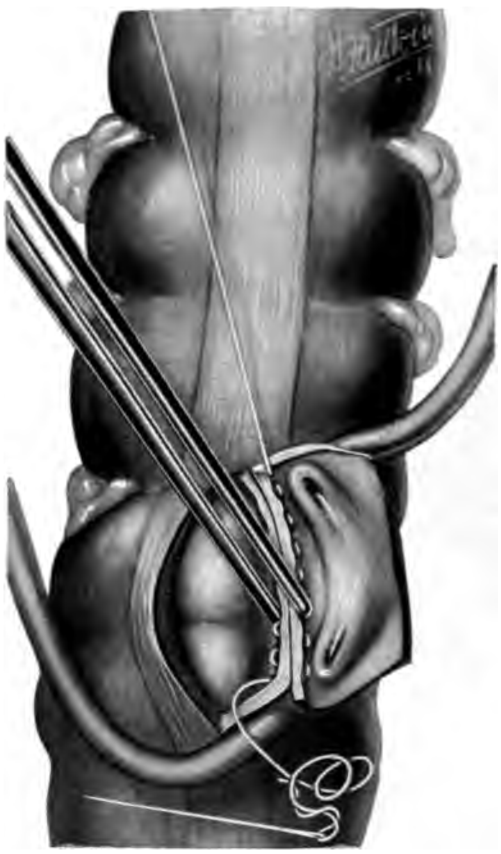
The indictment that we are compelled to bring against rectal implantation of the ureters, except by the method of Maydl, is summed up by Keyes[9] in the following words: "The results of the operation upon man have been but little better" (than upon animals). "According to Peterson, double implantation has been performed 18 times, with 8 deaths (44 per cent.) immediately due to the operation, and 3 deaths from a subsequent pyelonephritis (total mortality, 61 per cent.). Unilateral implantation fared somewhat better, with 3 primary deaths among

15 cases, and 2 secondary deaths. Of those followed for more than a month after operation, Peterson has compiled the following table:

1 ureter implanted, well after	6 months.
1 ureter implanted, well after	18 months.
1 ureter implanted, well after	2 years.
1 ureter implanted, well after	8 years.
2 ureters implanted, well after	5 weeks.
2 ureters implanted, well after	3½ months.
2 ureters implanted, well after	10 months.
2 ureters implanted, well after	1 year.
2 ureters implanted, well after	3½ years.

"It is obvious, then, that about 1 out of every 3 patients in whom unilateral implantation is done may be expected to live (whether with an

FIG. 447



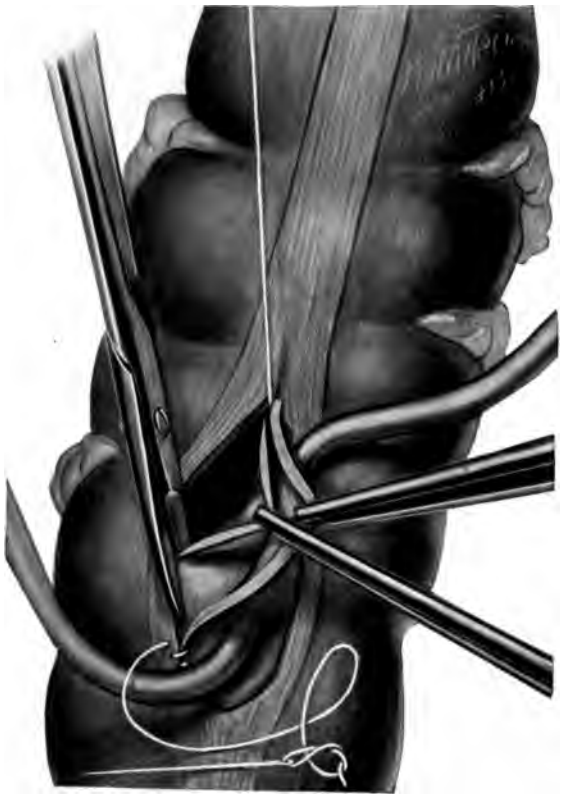
Maydl's operation as modified by Peterson. First step.

atrophied kidney or not, we need not decide), while 1 in every 4 bilateral implantations should recover. This evidence is, I agree, ample to con-

demn either procedure, even without the strong probability that the survivors all have damaged kidneys."

Those who may be especially interested in studying the experimental work upon animals with reference to intestinal ureter implantations are referred to the following writings upon the subject: Bovée,[8] Krynski,[10] Martin,[11] Van Hook,[12] Chaput.[13]

FIG. 448



Maydl's operation as modified by Peterson. Second step.

Maydl's Operation.—Incision.—Median abdominal.

Operation.—The bladder is freed from its attachments to the anterior abdominal wall and the ureter is tied and divided on the bladder side of the ligature. This leaves the organ held by its ureters only. A piece of the bladder, including the ureteral orifices and a margin of the bladder around them, is cut out of the rest of the wall of the bladder (Fig. 447). The bladder is then freed from its last attachments and removed.

The sigmoid flexure is next drawn into the opening made by the removal of the bladder and an incision is made in it longitudinally. This cut should be a little smaller than the longest dimension of the flap

taken from the bladder and does not include the mucosa. The vesical flap is next fitted into the incision in the bowel in such a way that the serous surfaces of it and of the bowel incision are approximated to each other. The flap is then sutured to the edges of the intestinal incision along one side, adapting the edge of the serosa of the flap to that of the bowel, and using a continuous stitch. When all but one of the sides of the flap have been attached in this way, a window is cut through the

FIG. 449

Maydl's operation as modified by Peterson. Third step.

mucosa of the bowel, large enough to draw it back beyond the ureteral orifices and to leave them clear. The rest of the edges of the flap and the intestinal incision are then stitched together and a reinforcing line of suture may be set in the serosa of both, to insure against leakage (Figs. 448 and 449).

The operation is concluded by closing the abdominal incision, except for a sufficient space to allow the passage of a drain.

DERMATO-URETEROTRESIS.

The object of this operation is to divert the urinary secretion from its natural channel to the skin. It is sometimes also done under the necessity created by the accidental division or wounding of the ureter, in the course of intra-abdominal operations, or because of the duct having been wounded by trauma or perforated by ulceration (by calculus).

The implantation has been made upon various parts of the surface of the abdomen and loin. It should be made at whatever part of the surface is most convenient for attaching the ureteral end. If the choice is open, the loin is to be preferred for the purpose.

Operation (transplantation onto the loin).—The incision, three or four inches long, is made parallel with and about an inch and a half above the iliac crest. Separate the fibers of the external oblique muscle; divide the internal oblique and transversalis; expose the peritoneum and push it upward and toward the middle line; search for the ureter, and separate it from the peritoneum for a few inches; ligate it with two ligatures just above its point of crossing the iliac bloodvessels, and divide the duct between the ligatures. Make a small incision through the loin, close to the outer border of the quadratus lumborum muscle. This can be conveniently done by passing a large steel sound or pair of curved forceps into the incision already made, pressing the tip of the instrument firmly against the inner surface of the loin and then cutting down on it from the skin. The ligature upon the severed end of the upper segment of the ureter should have been left long. A pair of forceps is next passed through the second, or loin incision, from without inward; its end is brought out through the first incision; the long ligature upon the ureter is caught by the forceps and drawn out through the upper opening together with the end of the ureter which is attached to it. The end should be drawn out a little way beyond the surface of the body, and while in this position it should be attached to the subcutaneous tissue by a ligature which should not be made to penetrate the inner coat of the duct. The end of the ureter is then cut off outside the ligature and split in two longitudinally, for a short distance. The halves of the ureter on each side of this incision are then turned back, and sutured to the margin of the skin wound on either side.

Comment.—The objection to this, as to all other forms of ureteral implantation, lies in the tendency of the implanted orifice of the duct to contract, and the liability to the occurrence of compression of the canal at the point where it traverses the wall of the loin or abdomen, or whatever structure it passes through in order to be implanted. There is also a chance that pressure may be exercised upon the canal at some

point between the implanted end and the renal pelvis by the formation of adhesions and their contraction upon it. If this should take place, the drainage from the kidney would become obstructed—as it happened in Harrison's case[14]—and hydronephrosis or pyonephrosis would be produced, finally when either of these two conditions are present the ureteral canal may not afford sufficient drainage to relieve them; even though no contraction of it takes place.

There are 13 cases of skin implantation of the ureter reported; 10 of these are reported by Bovée; the remaining 3 are by Bardenheuer, 1, and by Bottomley, 2.

The postoperative history of 8 of these cases is known. They are reported by: Harrison,[14] Bardenheuer,[15] Le Dentu,[16] Pozzi, Büddinger, Fullerton, and Bottomley. Le Dentu's[16] patient died of malignant disease, for the relief of which the operation was performed. The kidneys were not infected. Pozzi[17] removed the kidney on the same side as that on which he had implanted a divided ureter on the surface of the body three months previously. Albarran, who examined the organ, reported that it showed no pathological lesion.

Büdinger's[18] patient died from renal suppuration which is said to have been present prior to the operation.

Fullerton's[19] patient died four months after the operation from recurrence of malignant disease. The kidney of the implanted ureter was infected.

Bottomley[20] reports two cases; in one of them the operation was done for the relief of ectopia of the bladder, the patient making a good recovery and being in excellent health eighteen months after the operation. In the second case the operation was done as a preliminary step to total extirpation of the bladder for tumor of that organ. The patient made a prompt recovery from this procedure and bore the removal of the bladder well, but died five weeks later.

IMPLANTATION INTO THE OTHER URETER (TRANSURETERO-URETERAL ANASTOMOSIS).

The work upon this subject has thus far been experimental and carried out in dogs. It is an operative procedure that seems to be attractive and to present certain advantages, but the conditions which would make it appropriate appear to us to be limited, and we can only say that, should the opposite ureter be more readily accessible than the bladder, in any given case, it might be well to put the suggestion in practice.

The two most obvious objections to this method of implantation are, that the outflow of urine from the other kidney might be obstructed by the implanted end of the ureter of its fellow organ, and that the kidney

into whose ureter the severed end of the other one was implanted might readily become infected should the kidney of the other side already be so. If neither of these accidents should happen, and should the operation prove otherwise successful, the patient's comfort would certainly be greater than with any other form of implantation except that into the bladder.

URETHRO-URETEROTRESIS.

Bovée has collected five cases in which the ureter has been anastomosed with the urethra. In four of these the operation was done for ectopia of the bladder.

Sonnenburg[21] was the first to perform the operation. The anastomosis was successfully accomplished, but the patient was obliged to wear a receptacle, because of the constant dribbling of urine.

Lindet[22] joined the ureter to the bladder in an operation for the removal of a vesical tumor. The patient died of uremia. The autopsy showed that the corresponding kidney was invaded by a malignant growth, and that the ureter had not served to convey any urine from it.

In two other cases—those of Eastman and von Iterson—the results were successful.

OPERATIONS IN WHICH LOSS OF SUBSTANCE IN THE URETER IS SUPPLIED BY SPLICES MADE FROM NEIGHBORING STRUCTURES.

Rydygier's[23] method consists in bringing the two ends of the ureter out through the abdominal incision made in performing an intra-abdominal operation, during which the ureter has been injured or purposely divided. The abdominal incision is then allowed to heal, leaving the two ends of the divided ureter projecting above the surface.

The loss of continuity is then repaired by making a flap of skin (on either side of the ends of the ureter) the edges of which are made by parallel incisions on either side of the healed abdominal wound, and the ends of the ureter which are adherent to it. The edges of the flaps are rolled inward and united to each other and to the ureteral orifices, the interval between the two latter being thus bridged.

Splice from the Bladder.—Boari[24] has described a method of splicing the ureter with a bit of the bladder, by which a flap of the organ is dissected from its anterior surface, and an opening made into the interior of the bladder at the base of this flap; its two edges are then turned backward and united in the form of a tube, the upper end of which is sutured to the end of the ureter.

Morris describes a similar plan to that proposed by Van Hook, and refers to it as follows:

"Implant the ureter upon the skin of the abdomen in the median line, as near the bladder as possible. Close the abdominal walls as usual, except for the presence of the ureter.

"When the patient has fully recovered from the primary operation, open the structures composing the abdominal wall between the ureter and the pubes, down to the peritoneum and the bladder. The peritoneum must not be opened. The bladder may be distended exactly as in suprapubic cystotomy.

"Make two incisions in the bladder parallel to the median line, beginning as near as possible to the peritoneum without prejudice to its integrity, carry them down at a distance of about 15 mm. apart toward the neck of the bladder under guidance of the finger. With scissors curved on the flat, the two incisions are now united at the lowest point, and hemorrhage is controlled with pressure forceps. We now have at our disposal a vesical flap of considerable extent, hinged above by a nutrient pedicle.

"The ureter is loosened from the skin and brought well down toward the flap, which is simultaneously raised to meet it. The vesical flap is firmly fastened back in its new position by catgut sutures passing through the neighboring muscles or fascia, and the end of the ureter is held in position by light catgut sutures, which pass through the loose peri-ureteral connective tissue, if possible, and through the muscular structures near at hand.

"The edges of the vesical flap are now sewed together to form a tube, into the upper end of which the ureter is introduced. A similar row of light catgut sutures is placed close to the bladder wound itself. The lower angle of the vesical incision is best left open for the sake of drainage. The upper part of the skin wound, together with the fasciæ, may be closed.

"The bladder can thus be plastically extended to meet the ureter without opening the peritoneum, when the ureter is brought out upon the abdomen at any point more than 8 cm. (about 3¼ inches) below the umbilicus.

"The bladder flap can be made considerably longer, indeed long enough to meet the ureter at any point one inch or more below the navel, if the peritoneum is opened transversely at or very near its vesical reflection and sutured to the back of the bladder as low down as possible. The remaining steps of the operation after the peritoneum has been thus transplanted to the base of the bladder are the same as those which are mentioned above, and if the urine is aseptic, they should be performed at once."

Comment.—This operation has not been performed upon the human subject.

Further experiments with splicing operations have been tried or suggested; thus engrafting of the divided end of the ureter into the Fallopian tube and the uterus (d'Urso and Fabii). By making a splice of a small portion of resected intestine, the nutrient bloodvessels of which are not interfered with, and each end of which is ligated (the severed ends of the intestine from which it was resected being joined together again). Later, the ends of the divided ureter are implanted into the resected portion of the gut.

None of the so-called splicing operations appeal to us, except from the point of view of laboratory experiments. There are a variety of other procedures which have been suggested and carried out experimentally, to which it does not seem worth while to assign a place in a work of this character.

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CHAPTER XXX.

TUBERCULOSIS OF THE GENITO-URINARY TRACT.

Introductory Note.—In the greater part of the writings upon surgical diseases of the genito-urinary organs tuberculosis is dismembered and scattered in fragments through the volume under different headings, in such a way that it would not be surprising if a student were to have the impression that each one of them represented a distinct disease. Thus we find tuberculosis of the testicle, tuberculosis of the bladder, renal tuberculosis, etc., each discussed as an independent subject.

Inasmuch as the disease is one and the same throughout the whole extent of that part of the body with which this work is concerned, it seems to us to be a far more intelligent way of dealing with the matter to treat genito-urinary tuberculosis as such, and in continuity, and we have accordingly placed all its separate anatomical divisions together in one chapter.

Confusion is likely to arise with respect to the meaning which is intended by the word primary as it is usually employed by writers upon genito-urinary tuberculosis, it being difficult to understand whether it indicates that the disease is primary with reference to the whole body or merely with regard to the other parts of the genito-urinary tract. We shall, therefore, at the risk of being tedious through repetition, specify which of the two is intended whenever the term is used.

General Considerations.—*Primary and Secondary Tuberculosis of the Genito-urinary Organs.*—Tuberculous infection seldom occurs in the genito-urinary tract as the primary manifestation of the disease in the human body. As a rule, it is secondary to a focus of the infection elsewhere; in the majority of cases in the lungs and in the bones. That the disease does occur in a certain proportion (variously estimated) in the genito-urinary tract without any other part of the organism being involved —at any rate at first—has been clearly demonstrated.

Küster[2] holds the directly opposite view, and explains the cases in which no tuberculous lesions have been found in the body elsewhere than in the genito-urinary tract by the supposition that they have not been recognized because of being healed or of small extent, and easily overlooked; this, however, is a form of negative reasoning that is unconvincing.

In this connection the case reported by Crandon[3] is of interest.

In Crandon's case there was a well-marked tuberculous process in the prostate, and a most thorough postmortem search failed to disclose the smallest evidence of a tuberculous lesion anywhere else in the body.

In his admirable contribution to the subject of genito-urinary tuberculosis, Walker[1] found that the disease was stated to be primary in the genito-urinary organs with reference to the whole body in 52 out of 174 cases in which these organs were involved in tuberculous processes.

The Relative Frequency with Which the Different Parts of the Tract Are First Invaded.—In a majority of male patients and in a much greater number of females the first part of the genito-urinary tract to be invaded is the kidney, the lower parts becoming involved later by a descending infection. Walker[1] found, in a series of 279 cases, that the kidney was the first part of the genito-urinary tract to be attacked in 184, the epididymis in 80, the prostate and the Fallopian tubes in 6 each, the seminal vesicles in 2, and the uterus in 1.

It is very rare for the bladder to be the only part of the tract to be involved in the infection. Saxtorph[4] reports 1 such instance occurring in a female subject.

The much larger number of cases in which the disease is seen—as an older process, at any rate—in the kidney than elsewhere in the tract; the large number in which it is found to be the only one of the genito-urinary organs involved, and the very significant statement of Halle and Motz,[5] that in 100 cases examined by them they found a number in which tuberculous processes were present in the renal pelvis and ureter, while the bladder and lower part of the tract were free from such lesions, but they had not seen an instance in which the renal pelvis and ureter were involved *without* the corresponding kidney sharing also in the infection, all point to the inevitable conclusion that descending infection from the kidney is the rule, ascending infection from below to the kidney the exception. This is, in fact, the view held by almost everyone today.

When the lower part of the tract is invaded first the epididymis is by far the most frequent structure to suffer, the testicle much less often. From the epididymis the disease advances through the vas deferens to the seminal vesicle, the prostate, posterior urethra, and bladder in the cases in which extension occurs.

The Manner in Which the Disease Invades the Genito-urinary Organs.—Whenever there is *descending* infection from the kidneys to the lower part of the tract the invasion of the genito-urinary organs may take place through the blood current or by direct contact with the infected urine; in the *ascending* form of the disease it progresses upward by direct extension through contiguous tissues or by the lymphatics, although Walker asserts that it has not been demonstrated that lymphatic chan-

nels exist which pass to the kidney. Others maintain that they do, and that there are cases in which the infection may mount to the kidney from the ureter through them.

The Two General Forms in Which Genito-urinary Tuberculosis Appears.—1. As one manifestation of a general miliary tuberculosis. This is far more frequent than the other variety.

2. In the chronic form, in which the disease has the character of cheesy or suppurating foci of varying extent and in various stages of advancement, or of ulcerative processes of different depths and size, and which may be either diffuse or more or less well localized in some one part of the tract. It is this variety of the malady which is of special interest to the surgeon, because of the possibility which it offers of cure in a certain proportion of the cases, and it is the only one which will be considered in the present work.

Ascending and Descending Infection.—The question of ascending and descending march of the tuberculous process through the different parts of the genito-urinary tract is not of academic interest merely, but involves very practical considerations, more especially with reference to the surgical treatment.

If, for example, we believe, with Halle and Motz,[5] that the process rarely, if ever, reaches the kidney by an ascending invasion against the direction of the urinary current, and that descending infection from the kidneys is the rule to which there are but few exceptions, there is, on the one hand, greater hope of cure being obtained and of avoidance of further extension of the disease to other parts below, by removing the kidney, if we can detect the presence of the disease when it is confined to one of the two organs, and before the lower parts of the tract are invaded; while, on the other hand, there is less reason to remove a tuberculous testis, for example, so far as the danger of the kidneys becoming secondarily involved from it is concerned. This would not, of course, apply to the removal of the testis in so far as it was intended thereby to avert extension from it to the other testis or to the prostate.

Again, it would make illogical attempts to cure vesical infection by surgical procedures in any case in which repeated reinfection was constantly threatened by the existence of the disease in the kidney.

The observations of Halle and Motz upon which they support their belief in the rarity of ascending infection, and the frequency of the descending march of the process are as follows:

1. When the kidney is not involved the ureter remains normal throughout its length, even when the bladder is the seat of the most extensive tuberculous lesions and even when the vesical ulceration may have gone to the point of dissecting the ureteral orifice and the vesical

termination of the canal entirely away from the surrounding structures, leaving it detached, *but with its own tissues intact.*

"2. When, on the contrary, there exists a *destructive* tuberculous process of the vesical ureteral orifice and termination of the canal, there is invariably associated with it renal tuberculosis of the corresponding side.

"3. Ureteral tuberculosis *never* exists *without renal tuberculosis.* It does occur in the *absence of vesical tuberculosis*, and in some other instances in which vesical tuberculosis does exist it is limited to a small area around the orifice of the ureter."

So far as the writer is aware the above facts have not been controverted by reliable evidence to the contrary. The cases in which, at first sight, it might appear that there had been an ascending process from the bladder to the ureter, that is to say, those in which there are extensive ulcerations of the viscus, and in which the lower part of the ureter is deeply involved, while its upper portion is markedly less so, Halle and Motz assert will never be found without association of a deep-seated, even though it may be a limited, tuberculous lesion in the corresponding kidney.

They assume that the origin is renal in these seemingly contradictory instances. This seems to us to be the weakest point in their contention against the existence of an ascending infection, for it does not explain why the lesions should be so much more marked in the lower than in the upper segment of the ureter in those particular cases.

Even if it be admitted that both ends of the tract are equally liable to be the starting point of the infection, it still leaves it open to doubt in these instances from which end of the ureter the process has extended, and with the probability in favor of the starting point having been in the bladder, and the march upward into and through a *part* of the ureter, at any rate. In such cases it would seem to be more likely that there were originally two foci of infection—one in the lower and one in the upper end of the genito-urinary tract—and that the ureteral invasion probably took place from both rather than from one alone; but until it is conclusively shown that there has been actually observed a specimen in which the ureter is invaded in association with tuberculous lesions of the bladder, and in which there is an *entire absence* of any tuberculous process in the corresponding kidney, the theory that the ureteral lesion is secondary to those of the kidney, and that it may very likely never proceed from the lesions of the bladder, must be allowed to be probable, especially in view of the other facts noted above, which tend to strengthen this idea.

The Avenue of Invasion of the Bladder.—In the case of the bladder, it is clear that it may be reached and infected by a tuberculous process extending from the epididymis, testis, or prostate via the posterior urethra, for there are cases in which the disease occupies these parts of

the tract, and in which the ureter and kidney remain wholly intact and normal. That this manner of entering the bladder is less frequent than that in which it becomes infected from foci of the disease in the kidney is shown by the greater number of instances in which the viscus is involved in association with the latter organ, as compared with those in which it appears in connection with the disease in the epididymis and adjacent parts, and also by the very considerable number of cases in which tuberculous disease of the testis or epididymis exists without any corresponding invasion of the bladder.

The Manner of Involvement of the Epididymis and Testicle.—The large proportion of cases in which the epididymis or the testicle, when they are involved at all, appear clinically to be the first seat of a tuberculous process in the genito-urinary tract, and the considerable number in which the disease, so far as can be determined, remains limited to these structures, point strongly to the probability that the infection reaches them via the blood current. That it *may* gain access to these parts by extension through the vasa deferentia from the vesiculæ seminales or the prostate and posterior urethra is also true.

Summarized in brief, the views with regard to the direction taken by the tuberculous process in the genito-urinary tract, after its implantation there, and the parts of the tract which are most frequently the first to be attacked by it, may be stated thus:

The kidney is the most frequent primary seat of the disease in the genito-urinary tract; next to it, the epididymis; and then, in order, the Fallopian tubes, the prostate, the testis, the uterus, and the seminal vesicles. The bladder and the ureter have each been reported as being the primary seat of the genito-urinary manifestation of the malady, but the observations are not accepted as conclusive.

The Effect of Secondary Infection with Organisms Other than the Tubercle Bacillus in Association with Tuberculous Infection.—The engrafting of secondary pyogenic microörganisms upon an already existing genito-urinary tuberculous infection largely determines here, as it does in connection with tuberculous processes elsewhere in the body, the subsequent course and character of the resulting lesions.

Thus the natural tendency in certain parts of the urinary tract in the cases in which there is a pure tuberculous lesion only is toward ultimate cicatrization as the end-result of the preceding destructive conditions which are produced by the tubercle bacillus and its activity in the tissues in which it has become implanted. The best example, perhaps, of this sequence of events is to be found in the cases in which the tuberculous process has resulted in a total obliteration of the renal pelvis and (or) the ureter, and concomitant destruction of the renal substance.

When, however, there are other pyogenic microörganisms engrafted upon the original tuberculous areas of infection, instead of this reparative cicatrization, there is evinced no such tendency, but, on the contrary, suppuration is continuous, and the discharge — or throwing off — of caseous masses is not succeeded by any healing or cicatricial process. A greater degree of constitutional disturbance, and usually a more rapidly unfavorable course, ensues upon the introduction of such septic elements as those just mentioned.

RENAL TUBERCULOSIS.

The former teaching of the pathologists, and, indeed, of some of them at present, has been that the kidneys are *never* the primary seat of tuberculous lesions in the body, that unilateral infection does not occur, and that there are few, if any, authenticated instances of healed tuberculous lesions of the kidney other than those in which the process has been terminated by total destruction of the kidney through occlusion of the ureter or by extensive suppuration.

The recent clinical methods by which it has become possible to study the early stages of the infection in the genito-urinary tract in vivo have shown that some of the views just mentioned are incorrect, and it appears that, although not of frequent occurrence, yet it does happen that the kidney is the first part of the body to become the seat of tuberculous lesions, and that, whether it be primary in this sense or secondary to foci of the disease elsewhere in the organism, it affects but one of the kidneys at first in a majority of the cases. How often spontaneous healing of renal tuberculous lesions takes place, if at all, is very doubtful, and in this respect the former pathological view is probably near the truth.

Unilateral and Bilateral Renal Infection.—We have already, under the heading General Considerations, discussed the manner in which the tuberculous infection invades the kidney and the relative frequency with which the organ is the first point in the genito-urinary tract to be attacked. A word more should be said with regard to the evidence of its unilaterality or bilaterality in the beginning and the period during which the process may remain confined to one of the two kidneys.

Postmortem Evidence of Unilateral Renal Infection.—Halle and Motz[5] found, in 131 cases of renal and ureteral tuberculosis examined by them postmortem, that the tuberculous lesions were confined to one side in 89, and were bilateral in 42. In 39 of the cases the opposite kidneys and ureters were absolutely normal; in 17 others they were the seat of pathological processes of one or another sort, but *not tuberculous*.

Bevan[6] quotes the postmortem findings in the cases of renal tubercu-

losis which occurred in a total number of 13,000 autopsies of all sorts of diseases at Kiel. In this series it appears that 36.7 per cent. of all the tuberculous renal infections were confined to one of the two kidneys.

Walker[1] quotes Kryzwicki as having collected 94 cases in which post-mortems showed the disease to be confined to one of the two kidneys.

Clinical Evidence of Unilateral Renal Tuberculous Infection.—The testimony of this nature upon the unilateral occurrence of renal tuberculosis is derived from and based upon the examinations of the urines drawn separately from each of the two kidneys and from the facts with regard to permanency of the cures or entire absence of evidence of the existence of renal tuberculosis subsequent to nephrectomy of the kidney which is known to be invaded by it. Upon evidence of this character, such surgeons as Krönlein, Israel, Kümmel, Rafin, Kelly, Bevan, Reynaud, Casper, and Hurry Fenwick assert that the process, at the time at which the patients were examined by them, was confined to one kidney in from 50 to 80 per cent. of the cases.

Predisposing Conditions Which Invite Tuberculous Infection.—Trauma has been thought to be a predisposing factor to tuberculous disease of the kidneys. The influence of preceding renal injury upon the production of renal tuberculosis, while theoretically favorable to it, cannot be established with certainty. The fact that certain patients have developed renal tuberculosis subsequently to the occurrence of an injury to the kidney is entirely inconclusive, since they may have already had the disease in an incipient form; and, moreover, there is the fact that it has not been noted that a strikingly large number of persons whose kidneys have been injured have subsequently developed renal tuberculosis. *Experimental research* with reference to this point indicates that trauma does act as a predisposing cause. Upon this ground, Walker warns against the employment of exploratory procedures upon the opposite kidney at the time of performing nephrectomy upon its fellow organ.

Gonorrhœal disease as a predisposing cause of renal tuberculosis has not been demonstrated. It is, on the contrary, stated by some observers that the two microörganisms do not live upon friendly terms, and, if anything, are probably destructive to each other or one to the other. The evidence upon the latter point is thus far inclusive.

Manner in Which the Kidney is Invaded.—*Hematogenous and Ascending Infections.*—We have already said that the tuberculous infection reaches the kidney by the blood current in the great majority of cases. When this is the avenue of approach, the disease is lodged in the kidney by the depositing of minute and infected emboli in the finer terminal capillaries of the arterial bloodvessels of the organ. These emboli have their origin in a more or less well-marked primary foci of tuberculous disease else-

where in the body. In the cases in which there is no such lesion present, and in which it is believed that the tuberculous condition is primary in the kidneys, it is assumed that the bacilli of the disease, which have entered the organism in most instances through the lungs or alimentary canal, have found in the kidney a point of weakened resistance which invites their remaining there, and that the renal process takes its origin in this way.

Passage of Tubercle Bacilli through the Kidney without Causing Renal Tuberculosis.—That this may and does happen has been shown by a few postmortem examinations in cases in which tubercle bacilli had been found in the urine during life and no tuberculous lesions were present in the genito-urinary tract after death, and by numerous observations of a clinical nature in which the bacilli have appeared in the urines of patients who never subsequently showed any sign of tuberculous disease anywhere.

Failure to Find Tubercle Bacilli when the Disease Exists in the Kidney.—Numerous cases are reported in which it has been believed, and subsequently been proved, that renal tuberculosis has been present, and in which, during longer or shorter periods, no tubercle bacilli have been found in the urines of the patients. Walker[1] believes that this has been due in many instances to the use of inadequate methods in making the examinations, and states that, if the examinations are conducted properly, the bacilli will almost invariably be found.

The Smegma Bacillus.—A common source of error in making the examinations for tubercle bacilli is that of confounding the smegma bacillus with it. Walker quotes instances reported by Bunge and Trautenroth in which radical operations have been undertaken on the strength of the discovery of the smegma bacillus, it being believed that it was the tubercle microörganism. It is asserted by some authorities that it is not possible to be absolutely certain of distinguishing between these two microörganisms; such has been, according to Walker, the statement made by Trudeau. If this is the fact, we should *never* be content with the microscopic examination alone, and inoculations should always be the decisive means whereby to judge of their character.

Pathological Anatomy.—There is a multiplicity of different classifications of the disease as it appears in the kidney and its pelvis, which we believe to be quite needless, and which are more effective in confusing the student's mind than in serving any useful purpose.

Leaving out of consideration acute miliary tuberculosis of the kidney, which is not a surgical malady, the variations in the appearance of the tuberculous lesions correspond either to the different stages of the advancement of the disease or to the avenue through which the organ

has been invaded; that is to say, whether through the blood current or by ascending infection. In the late phases of development, in which great destruction of kidney tissue has taken place, it is quite impossible to determine from the appearances alone in what way, or through what avenue, the disease originally occupied the organ.

FIG. 450

Renal tuberculosis, with the foci distributed at the bases of the pyramids.

There are three essential pathologico-anatomical changes in the kidney as a result of tuberculosis. These are: (1) *Foci of tuberculous deposit.* (2) *Surrounding zones of inflammation and inflammatory exudation*; and (3) *interstitial nephritis* more or less widely extended in the adjacent parts of the kidney.

Apart from these essential lesions there occur differences in the size,

number, distribution, and [illegible] of the disease in the kidney. Thus in some [illegible] numerous relatively small foci of [illegible] more or less widely through the subst[illegible] the organ; in others there are a few [illegible] of the bases of the pyramids [illegible] conspicuous feature will be the location [illegible] ends of the pyramids. Shallow, [illegible] apices of the pyramids, in a few [illegible] takes the form of ulceration of the [illegible] accom- panied by an infiltration and [illegible]

[illegible]

[illegible] pyramids.

[illegible]

nephrosis, for the production of which, obstruction to the outflow of urine from the kidney is necessary; while in these cases to which we refer the pus cavities in the kidney may be created in the absence of such an obstacle. When, however, a hydronephrotic kidney is invaded by tuberculous infection, a true pyonephrosis may result.

Character of the Lesions in Ascending Infection.—In the cases of ascending infection the renal pelvis is attacked before the kidney, and the apices of the pyramids before their bases and before the renal parenchyma. In the renal pelvis and on the apices of the pyramids the process takes the form of ulcerations. The same character of lesion may occur in the body of the pyramids and in the renal parenchyma also, or at first it may have the form of nodules, which later proceed to form abscesses or foci of cheesy degeneration, varying in size according to the stage of advancement of the disease, in the final phase of which the entire kidney substance may be destroyed.

The Character of the Lesions in the Hematogenous Infection.—The characteristics of hematogenous infection are the situation of the cheesy foci and their occurrence in the form of nodules usually of considerable size. These occupy the lines of distribution of the terminal twigs of the renal bloodvessels, in which the process takes its origin in the kidney from the lodgement of minute infective emboli in the arterial capillaries. The starting points are, therefore, about midway between the bases of the pyramids and the cortex of the renal substance.

These foci later become confluent, and may break into the renal pelvis on the one side, or into the perirenal envelope on the other, in the more advanced stages of the disease. At first the cheesy masses present no areas of softening; later, they break down centrally and liquefy in that part of the nodules.

Plate XLVI illustrates a typical case of this form of the process.

This is the most common variety of the disease met with in the kidney. Israel found it in 48 out of 74 of his cases. Next in frequency in the same series was that form of the lesion in which the process is located in the heads of the papillæ—23 of the total 74.

In the first of the above-mentioned forms there are always zones of intense inflammation surrounding the cheesy foci and radiating eccentrically from them.

Nephritis.—It is an open question whether the nephritis which so frequently accompanies the tuberculous lesions of the kidney is produced by the bacilli or by their toxins. According to Albarran the toxins cause a glomerulonephritis. Whatever may be the manner of its production, an interstitial nephritis exists which is in close relation with the foci of the tuberculous process.

PLATE XLVI

HEMATOGENOUS INFECTION. RENAL TUBERCULOSIS (Fenwick)

Reynaud[7] states that it has been experimentally demonstrated that the bacillus of Koch produces lesions of the vascular and connective tissues of the kidney, which result in sclerosis of the organ.

The Perirenal Envelope.—The changes in the perirenal tissue are those of chronic inflammation, which converts the fat into connective tissue. The deposit of the latter in many cases is extensive. This is of much practical importance, since it may render nephrectomy very difficult, if it is attempted in the ordinary way, because of the presence of adhesions to the renal bloodvessels or to the vena cava and the aorta. On the other hand, it renders its performance easy if the intracapsular method be employed.

Age, Sex, and Relative Frequency with Which Each Kidney is Attacked.—*Age.*—Walker,[1] in an analysis of 373 cases, found that the average age of the patients was 27.66 years, and that the largest number of those affected by the malady was in the decade from twenty to thirty years.

Sex.—The same author states that in a total number of 386 patients, 182 were males, 204 females.

Relative Frequency with Which Each Kidney is Involved.—Walker found, in a series of 216 cases, that the right kidney was affected 111 times, the left 96 times; not stated in 9.

These figures are approximately the same as those reported by various other writers with reference to these factors.

Symptoms.—The symptoms are *general* and *local.*

General Symptoms.—In some cases the disease may progress for a long time without causing any marked symptoms of systemic or general character.

In the great majority, however, careful inquiry will show that there has been, from what may be presumed to have been an early stage of the malady, more or less malaise, some nervousness, irritability, very probably the sense of being flushed and uncomfortably warm in the afternoon, slight impairment of the appetite, and disturbance of sleep.

As the disease progresses these symptoms become more marked, and, in addition, there occur loss of weight and the regular afternoon rise of temperature, not exceeding, as a rule, 103°, and more often ranging between 101° and 102° F. In the later stages, prostration and, when both kidneys are sufficiently involved, uremia occur.

Local Symptoms.—The first evidence of the disease to attract the patient's attention is usually *irritability of the bladder.* Later this becomes more severe, and if the bladder is involved in the process is succeeded by pain, which varies from being moderate to being a torturing vesical tenesmus. Irritability of the bladder is often caused by the presence of the disease in the kidneys, and may be very marked without

any vesical lesion being present. It is this symptom of the renal condition, especially when it is accompanied by the presence of pus in the urine, that is the cause of so many errors of diagnosis, cystitis being assumed to be responsible for the pus. In the absence of any of the more common casual factors of cystitis—gonorrhœa, prostatic hypertrophy, stricture of the urethra—an acid instead of an alkaline urine, together with the presence of a renal tumor and local tenderness over the kidney, will usually correct the false impression that cystitis is the cause of the bladder symptoms in the cases in which confusion might arise.

Pyuria.—The occurrence of pyuria depends upon whether or not the tuberculous process involves the renal calices or pelvis or stands in such communication with them that pus can make its way to the bladder and appear in the urine. In the earlier stages of the cases of hematogenous origin—that is to say, in the majority—there will be no pus or but a very small amount of it in the urine. Later, and especially when a mixed infection has attacked the organ, pus will appear in varying amounts, at times being abundant, again but very little, and occasionally ceasing entirely. These alternations of clear and purulent urines are probably due to the emptying of successive tuberculous abscesses, which have broken into the calices or pelvis of the kidney and discharge their contents for a variable time.

The pus may be sufficiently thick to temporarily block the ureter and cause renal retention. The writer has seen two striking examples of this occurrence.

Hematuria.—In a few exceptional cases renal tuberculosis gives rise to abundant hematuria. These are the ones in which the process takes the form of ulcerations occupying the apices of the pyramids. As a rule, there is but little blood in the urine; if present, it is very apt to appear in the form of small, comma-like clots. In many instances it is in microscopic amounts only, and in some it is reported as being absent.

Hematuria is not an essentially characteristic symptom of renal tuberculosis.

As in the case of pus, the alternating presence and absence of blood in the urine is also seen.

Other signs connected with the urine are: Polyuria; a low specific gravity, in many cases at least; albumin in correspondence with the amount of blood and pus present and due to associated nephritis. Casts are often lacking; sometimes they occur. The urine is acid (even in the later stages of the disease) so long as the kidneys alone are involved and the bladder has not been invaded and become the seat of a mixed infection.

Remission of Symptoms.—Perhaps the most characteristic of all the symptoms of the disease are the remissions which occur in them. This

PLATE XLVII

[illegible]

is, of course, typical of tuberculous infections elsewhere in the body, and the kidneys and genito-urinary tract, when invaded, form no exception to the rule. The diminution or disappearance of blood and pus from the urine, of pain from the bladder and kidney, the gain of weight, and the lowering of the temperature to nearly normal, following the contrary conditions, is often very striking.

Renal Tumor and Pain.—The kidney is always more or less enlarged, and at times may be sufficiently so to form a large tumor in the loin. In the more extreme examples the greater part of the mass represents the thickened perirenal tissue; in a few others, perirenal suppuration; occasionally, and for a short time, renal retention, due to the blocking of the ureter by masses of cheesy pus, add to the size of the tumor. In the great majority of the cases the renal enlargement is too slight to be palpable in the early stages of the malady.

Renal pain is seldom severe in the earlier period of the disease; occasionally it is the first symptom to direct the attention of the patient to the fact that there is something wrong. It is usually of a dull, aching character, often accompanied by a sense of weight in the loin. When there is a mixed infection, and especially when abscess formation takes place, pain in the kidney becomes a conspicuous symptom, and is usually severe.

Diagnosis.—Pain, hematuria, and pyuria are not increased on exercise, as they generally are in cases of renal calculus. The hematuria has not the character of spontaneity that is seen in cases of vesical tumors, nor is it so abundant.

The diagnosis should rest not only upon establishing the presence of the disease in the kidneys, but must include a knowledge of whether or not it is confined to one of them; whether it involves the bladder; what the functional capability of each of the kidneys is individually; whether other parts of the lower portion of the genito-urinary tract are involved; and, finally, what other parts of the body are invaded by the infection, and to what extent they may be compromised by it.

The first three of these conditions may be determined by *cystoscopic examination of the bladder and ureteral catheterization.* The cystoscopic appearances in the bladder are, for those who are familiar with them, eminently characteristic of the disease in the kidneys as well as in the bladder itself.

Fenwick[8] describes the appearances of the ureteral orifice and the mucous membrane of the bladder immediately about it, on the side corresponding to the kidney involved in the tuberculous infection, and illustrates them in the figure which we have reproduced here. (Plate XLVII.) So significant does Fenwick consider these appearances that

he asserts that he needs no other evidence of the existence of tuberculous disease of the kidney of the side on which they are seen. Willy Meyer and some others hold the same view of the value of these appearances as guides to the diagnosis.

Ureteral Catheterization.—(For technique of this procedure, see chapter on Cystoscopy.) The best means at our disposal for estimating the functional capability of the two kidneys separately is by the examinations of the urines drawn from each of them individually with the ureteral catheter, and by the employment of the tests of phloridzin and cryoscopy, as well as the usual ones for urea and the other solid constituents of the urine. (The manner of making the phloridzin and the cryoscopic tests is given in the chapter on Urinary Analysis.)

Ureteral catheterization we regard as a far more reliable method of obtaining the two urines than that of segregation by any of the means as yet devised for the latter.

In addition to the testing of the functional capability by these methods, the urine should be examined for tubercle bacilli, and inoculations should be made. The presence of blood and pus is also of much significance in connection with the other evidences of the disease just mentioned.

If the urine of one kidney shows the presence of pus, or blood, or tubercle bacilli, or if inoculations with the urine of one kidney are positive, while those with that from the other show no pus, or blood, or tubercle bacilli, and the inoculations with it are negative, we have the right to conclude that the disease is present in the former and absent in the latter of the two kidneys.

It sometimes happens that the tests just named are negative at a certain time, while they may be positive at another, so that we should not rest content with a single examination. Tubercle bacilli may not be found for a considerable time, and then appear in large numbers. We have already referred to this fact as well as that of their passage through the kidney without remaining in the organ and producing the disease. It should also be remembered that the smegma bacillus is frequently mistaken for the tubercle bacillus; renal operations, indeed, have more than once been done needlessly because of this mistake. The liability to this error is less if the urines have been drawn carefully by ureteral catheters, but even then there is chance of error, and inoculations should always be the chief reliance.

It must be remembered that six weeks must elapse after inoculations of guinea-pigs before the results can be determined.

Prognosis.—Pathologists tell us that they see few if any specimens postmortem of *healed tuberculous lesions* of the kidney other than such as occur through total destruction of the organ by extensive suppuration,

which is not healing in the proper sense of the term. On the other hand, they are not prepared to assert that some of the cicatrices found in the kidney may not be healed tuberculous lesions.

If it were true that spontaneous healing *never* takes place in cases of renal tuberculosis, it is clear that the disease, left to itself, must invariably prove fatal. As a matter of fact, we have positive evidence of the arrest of the process spontaneously under favorable conditions in a few cases and an equally positive proof of its failure to do so in a very large number. The fate of the patient, moreover, very often does not depend upon the renal lesions alone, since death occurs in many cases because of tuberculous disease elsewhere in the body.

On the whole, we must say that the prognosis of renal tuberculosis is bad, even though the patient be placed under the best influences of palliative, hygienic, and climatic treatment. It is impossible to determine just what the proportion of cures may be under palliative treatment, but no one disputes the statement that it is a very small one.

Treatment.—The treatment is (1) palliative and (2) operative.

PALLIATIVE TREATMENT.—Palliative treatment consists in the proper application of the measures of hygiene, diet, clothing, bathing, rest, and climate.

These are far less efficient in cases of renal than in those of pulmonary tuberculosis. It is, however, undoubtedly the fact, so far as absence of all evidence of the existence of the disease can prove it, that a small proportion of patients recover under this treatment, in the sense of the process being arrested.

The hope that this will be the result in any given case is so small that this method of treatment should, in our belief, be applied only in the cases in which it is useless to do nephrectomy; that is to say, to those in which the contra-indications to nephrectomy exist.

OPERATIVE TREATMENT.—The operative treatment of renal tuberculosis consists of the following measures: (1) Nephrotomy. (2) Resection of a part of the kidney. (3) Nephrectomy.

The whole question of the surgical treatment of renal tuberculosis may be summarized thus:

Nephrotomy.—Nephrotomy is of service as a palliative measure, for the purpose of evacuating pus retained in the kidney, and for the relief of pain and fever due to such pus retention, when it occurs in cases in which nephrectomy is contra-indicated. There are a few instances reported—seven altogether—in which the evacuation of pus from a tuberculous kidney by nephrotomy appears to have resulted in a cure.

Nephrotomy may be a useful measure as a preparatory step to nephrec-

tomy, and is, in a number of instances, the only course that is open to the surgeon at the moment, because of prostration of the patient and the obvious inability to support the more serious operation of removal of the organ. Except under the above conditions, nephrotomy should have no place in the surgical treatment.

Nephrectomy.—Nephrectomy, when performed under proper conditions, is the only form of treatment of whatever kind by which we can hope to *cure* any important number of patients with this malady.

What are these proper conditions? They are as follows: (*a*) That the tuberculous infection does not involve both of the kidneys. (*b*) That there are no tuberculous lesions elsewhere in the body of such extent, or involving such organs or structures, as to render the performance of nephrectomy useless. (*c*) That the functional capability of the kidney to remain after the performance of the nephrectomy shall have been established beforehand.

When these conditions are present, nephrectomy will result in *cure* in from 25 to 30 per cent. of the patients, and at an operative risk of from 8 to 12 per cent.

The importance of establishing the functional capability of the kidney which is to remain after the removal of its fellow is well shown by the difference in the operative mortality of two series of cases, in which nephrectomies were done, and which the writer has collected from various sources. In the first series, which numbers 362, the tests of the functional capability of the other kidney were not made; the operative mortality was 35 per cent. In the second series, in which there were 292 cases, the capability of the other kidney was estimated; in this set the operative mortality was but 7.8 per cent.

The mortality attending the performance of nephrectomy in the hands of surgeons of skill and experience may be judged from the following table:

NEPHRECTOMY IN RENAL TUBERCULOSIS. OPERATIVE MORTALITY.

	Cases.	100 per cent. scale. 10 20 30 40 50 60 70 80 90 100
Albarran	42	3.4 per cent.
Krönlein	34	5.8 "
Israel	28	10.7 "
Kümmel	65	3.0 "
Rafin	32	6.5 "
Total	201	5.8 " average mortality.

More important than the immediate results are the remote ones. Walker,[1] in a series of 210 patients surviving after nephrectomy, in a total number of 267, gives the following data:

	Cases.
Reported as well	79
Recovered	83
Cured	20
Good results	4
Improved	7
Not improved	2
Improved at first, but failed to maintain improvement	15

In the last 15 cases cystitis persisted in 5, 2 showed involvement of the other kidney, 1 general tuberculosis, 1 pulmonary tuberculosis, and 3 ailing.

Keyes[9] gives the following figures:

98 primary nephrectomies—deaths 11, or 12 per cent.

7 patients died shortly after convalescence.

7 patients died of the disease at later periods.

63 patients, or 64 per cent., were reported as apparently cured.

The times mentioned at which the patients were reported to be cured were as follows:

	Cases.
21, 12, and 11 years, respectively	3
10 years	3
5 to 10 years	13
3 " 5 "	11
1 " 2 "	14
Total	44

In the remaining 29 cases no data are given.

In the series published by Reynaud,[7] including altogether 40 cases in which nephrectomy was done, the late results were reported as follows:

	Cases.	Cured.	Improved.	Not improved.	Died.
6 months to 1 year	5	3	1	1	
1 to 2 years	9	3	4	2	
2 " 3 "	6	2	2	1	1
3 " 4 "	4	1	3		
4 years or more	2	1	..	..	1 (10 yrs.)
Total	26	10	10	4	2

There were 3 deaths at earlier periods, making altogether 5 deaths more or less remote from the time of operation.

From these series of cases combined the following general and very important data appear:

1. That 74, or 23.9 per cent., of 309 patients surviving operation were cured.

2. That with 99 patients surviving in the two series reported by Keyes and Reynaud, cure was apparently established at the end of three or more years in 32.3 per cent., and if all cases reported in these two series as cured at times shorter than this are included the percentage becomes 54 per cent.

3. That 19 per cent. died after convalescing; one-half of this number dying of the disease and the other half of other maladies.

4. That in 9.7 per cent. of the cases available to make the calculation, it was known that *no* improvement took place.

5. Great improvement took place without cure being established, however, in 36.7 per cent. of 242 patients.

Improvement of tuberculous disease of the bladder following nephrectomy was a very marked feature of Reynaud's series. The consideration of this question will be taken up in the section on Vesical Tuberculosis, to which it is more appropriate.

Resection of the Kidney.—The resection of a part of the kidney affected by tuberculosis has always been, in our judgment, an irrational procedure, for the reason that it is impossible to define the limits of the process in the kidney with the naked eye, and because we know that the disease almost invariably extends to parts of the organ which cannot be inspected when the kidney is exposed and incised at the time of operation.

TUBERCULOSIS OF THE URETER.

Halle and Motz[10] describe the lesions of the ureters in detail. They divide them into *localized* and *diffuse*. The superficial lesions may be limited to a simple granular infiltration of the mucous membrane. They give the name *cavernous ureteritis* to the more destructive processes of ulceration which tend to form cup-like excavations upon the interior surface of the ureter.

The most frequent seats of the tuberculous process in the *localized form* are at the extremities of the canal. This variety is much rarer than the diffuse form.

The typical and most frequently encountered condition of tuberculous disease of the ureter, as it appears at postmortem examinations, is that in which the lesions are far advanced and there is a general breaking down of the infected structures throughout the whole length of the ureter.

In the less advanced phases of this variety of the condition the ureter has the form of a straight, thick-walled, hard, and partially obstructed tube. In a less common type the contrary conditions prevail; that is to say, the ureter is dilated, thin walled, and the ulcerative processes are confined to the mucous membrane.

The Vesical Orifice of the Ureter in Tuberculous Infection.—The appearances of the vesical orifice of the ureter in renal tuberculosis are of much importance, inasmuch as they have great diagnostic value in connection with the cystoscope. Halle and Motz[10] describe the conditions presented in 28 of their cases in the series examined by them, to which reference has already been made. They speak thus with regard to them: "In 13 of the 28 the ureteral orifice was the only seat of ulceration in the bladder. In 9 others, in which extensive vesical ulceration was present, the ureteral orifice had been destroyed and an infundibulum had been formed in the bladder wall immediately contiguous to it, which constituted the central and maximal focus of the process. In 6 cases the ureteral termination remained intact, but was dissected away from the surrounding parts, and appeared in the form of a projecting cord.

"In these last 6 cases the rest of the ureter and the corresponding kidney showed no tuberculous lesion whatever."

Peri-ureteritis.—Another important and interesting point which appears in their communication is with reference to the conditions found in connection with a number of the cases in which peri-ureteritis existed.

In its most extreme form this associated lesion is rare. They say that they have seen 14 cases in which all trace of the ureter was entirely lost, because of its being so amalgamated with the dense mass of peri-ureteral exudation and tuberculous infiltration that it formed simply the centre of a large fibro-adipose cord, extending from the kidney to the bladder. The serious bearing of the following facts upon removal of the ureter in connection with nephrectomy is obvious. In 3 cases there was close adhesion to the iliac vessel; to the vena cava in 2, and to the aorta in 1.

Two of the most important points concerning tuberculous disease of the ureter made by these writers are the following:

1. The ureteral orifice and the corresponding kidney were invariably the seat of long-standing, deep-seated, and advanced tuberculous lesions, in the cases in which the vesical lesion was limited to the part of the bladder immediately adjacent to the ureteral orifice.

2. In a number of the cases in which the renal pelvis and ureter were involved in the tuberculous process there were no lesions in the bladder or lower part of the genito-urinary tract, but in no single instance did it

appear that the renal pelvis and ureter were involved without there being present a well-marked tuberculous lesion in the corresponding kidney. This fact, as we have already pointed out, speaks strongly in support of the preponderance of descending infection as compared with the ascending form, especially when considered in connection with the other factors which contribute to strengthen this view.

Pathological Anatomy.—*Macroscopic Appearances of the Ureteral Tuberculous Lesions.*—Halle and Motz[10] describe the macroscopic appearances of ureteral tuberculosis thus:

"The initial lesions of the mucous membrane present themselves as small miliary granulations, in some places isolated, at others confluent, slightly raised above the surface, and about the size of the head of a pin. At first gray and translucent, they later become opaque and yellow. The former are rarely seen; the latter, as they become confluent, are common."

The above appearances are not often encountered in the human adult in the cases of chronic tuberculosis of the ureter.

The usual form under which the early lesions are seen is that of superficial ulcerations still limited to the mucosa. Later, the separate ulcerations join together and occupy more extended surfaces.

The next stage is that in which the deeper structures are involved. This form of the disease presents appearances which differ in different cases. In some there are deep-seated, separate areas of infiltration, which at first show no ulceration of the surface. They are elevated above the surrounding tissue, are hard, and involve the deeper ureteral structure.

Later, their surface ulcerates, they eat still more deeply into the underlying tissues, and present the characteristics of cheesy degeneration. In correspondence with these changes the process extends over a larger surface.

The form under which the lesions most frequently appear is that designated by Halle and Motz as "diffuse massive infiltration." In this variety the entire thickness of the ureteral wall is involved, sometimes in a limited area, and again, the ureter is affected throughout its whole length.

Obliteration of the Ureter as a Result of the Tuberculous Invasion.—Stricture of the ureter may result in consequence of an unmixed tuberculous infection; occasionally, total obliteration of the whole canal takes place through adhesions produced by the cicatrization of the tuberculous lesions, the corresponing kidney being wholly destroyed as well. Halle and Motz found eighteen examples of this condition of the ureter in their series of 100 cases.

TUBERCULOSIS OF THE BLADDER.

With but rare exceptions, tuberculosis of the bladder does not occur apart from tuberculosis of other parts of the genito-urinary tract. Saxtorph[4] mentions 1 case only out of 205 of chronc genito-urinary tuberculosis, in which the bladder alone was the seat of the infection. Heiberg[11] found 1 instance of the same in 54 cases of genito-urinary tuberculosis.

It has already been stated under the heading General Considerations that vesical tuberculosis is more often secondary to the disease in the kidney than it is to the disease in parts of the tracts below the bladder, but that when it becomes established in that organ from these lower parts, the infection probably arrives by direct extension through the contiguous structures which intervene.

Frequency of Bladder Tuberculosis.—Walker[1] quotes Saxtorph's data, in which it appears that of 205 cases of chronic genito-urinary tuberculosis there were 52 in which the bladder was involved in the infection, secondarily to the disease in other parts of the tract. In 38 cases the patients were males; in 14, females. In the 38 male patients the kidney was involved 32 times, the prostate 29 times, and the seminal vesicles 20 times. In the 14 female patients, the kidney 13 times and the genital organs 3 times.

Other data, which appear in the article of Walker, are these:

Posner found 12 examples of vesical tuberculosis in 115 cases of the disease in the kidney. Heiberg found 9 instances of vesical tuberculosis in 32 cases of genito-urinary infection in the male, and 9 out of 22 in the female.

Matile found 19 examples of vesical tuberculosis in 123 cases of the disease in the genito-urinary tract.

Gautier found 35 instances of vesical tuberculosis in 51 in which the kidney was infected.

Israel found 11 in 23 cases of renal tuberculosis.

In Walker's series of 411 cases of genito-urinary tuberculosis the relative frequency of the other parts of the tract from which the infection had been propagated to the bladder was as follows: the kidneys in 119, the prostate in 33, and the epididymis in 26.

The Influence of Pyogenic Organisms.—The noticeable frequency with which tuberculous infection of the lower parts of the genito-urinary tract follow upon gonorrhœa has been frequently pointed out. Just what influence the gonorrhœal invasion may have in preparing the soil for the entrance of the tubercle bacilli is not established, and it is difficult to determine, owing to the frequency of gonorrhœa. Walker states that

in 135 of the cases of his series, 71 of the patients had had gonorrhœa, and 64 of them denied its occurrence. He refers to the fact that Cornil, Motz, and some other observers have found gonococci and tubercle bacilli associated together in the urine.

The role of other pyogenic organisms, in inviting the invasion of the bladder by the tubercle bacilli, is that of weakening the mucous membrane structurally to a greater or less degree; but, as Walker points out, the disease will not, even under these circumstances, become implanted in the bladder unless some other part of the genito-urinary tract is already the seat of a tuberculous process.

The bladder is very resistant to the attack of the tuberculous infection, and although experimental research shows that injury to the mucous membrane favors the implanting of the tuberculous germ in the bladder in some cases, it appears that it entirely fails to do so in others, even after the mucous membrane has been scratched or otherwise injured. Rovsing has shown that tubercle bacilli injected into a healthy bladder, even if allowed to remain there for twenty-four hours, do not produce tuberculous infection.

Pathological Anatomy.—The tuberculous process is at first localized in the mucous membrane. The early appearances of the process are, in most instances, localized about the mouth of one of the ureters; in other instances, of both of them.

The lesion in the early stages has the form of small grayish-yellow nodules which later become confluent and form irregular-shaped, shallow ulcerations, upon the floor of which there is a dirty grayish-yellow necrotic covering. The edges of these ulcers are dotted with miliary tubercles.

In the vicinity of the ulcerated surfaces there are, in some cases, striking forms of mucous membrane hyperplasia. This process may progress to such a degree that it is readily mistaken, in a cystoscopic examination, for one of the more delicate varieties of vesical papilloma.

In the most extreme forms of the ulcerative process the whole inner surface of the bladder is involved, and its entire inner lining may be destroyed.

Microscopic Appearances.—These are described by Zuckerkandl[12] as follows:

"In the beginning of the tuberculous process the lesion appears as circumscribed, subepithelial, cellular proliferations, in the centre of which there are larger cells with clear nuclei and having the character of giant cells. On the circumference of the nodule of tuberculous new formation there is a rich cell infiltration and new formation of blood-vessels.

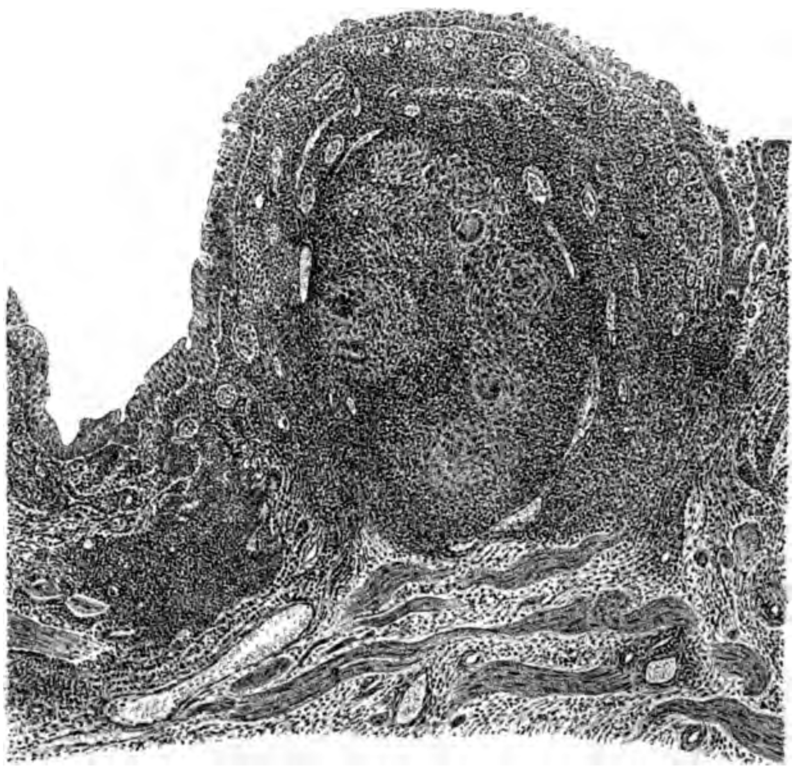
"Occasionally the process does not begin in the mucosa itself, but the

latter remains intact above the circumscribed area of tissue of the character just described, which occupies the submucosa."

The lesion termed by Zuckerkandl "conglomerate tubercle" (Fig. 452) consists or results from the confluence of individual nodules of the character described above.

The individual areas of tuberculous tissue are surrounded by an inflammatory process, the conspicuous elements of which are a rich cell infiltration of the meshes of the cellular tissue, while there is an actual

FIG. 452



Tuberculous conglomeration of the bladder. (Zuckerkandl.)

increase of the fixed tissue elements and an abundant new formation of bloodvessels.

In contrast to the proliferating process of the periphery, the tubercle nodule early undergoes cheesy degeneration; the cell nuclei disappear, at first in the centre of the nodule, later extending to the periphery. The epithelial covering is destroyed and exposes necrotic tissue which has taken its place, forming thus the characteristic ulcerating lesion. The ulcer advances from the centre toward the periphery of the tuberculous

nodule, and its edges consist of undermined and overhanging epithelium-covered mucous membrane, which makes a sharply defined border (Fig. 453). Tubercle bacilli are found in large numbers in the necrotic central tissue of the ulcer.

There is a considerable variety in the character of the ulcerations produced by the tuberculous process in different cases. These are dependent chiefly upon the different stages of development of the ulcerative condition. The more noticeable of the various forms are the trabeculated and the vegetating or granulation ulcers; sometimes the variety which Walker refers to as the "diphtheroid" form is seen.

Fig. 453

Miliary tuberculous ulceration of the bladder. (Zuckerkandl.)

Situation of the Tuberculous Process.—Walker gives the following data with reference to this point:

In 83 of the cases of his own series, it occupied the trigone in 27, the orifices of the ureters or their immediate vicinity in 23, the base of the bladder in 10, the posterior wall in 7, the vesical neck in 7, and the superior wall in 2.

He quotes the following figures from Le Fur with reference to this matter:

In 60 cases the lesions were situated as follows: About the ureteral orifices, 12; in the base of the bladder, 10; on the posterior wall, 9; in the trigone, 5; in the vesical neck and the trigone, 3; and in the vesical neck alone, 3.

Walker mentions a few cases in which perforation of the bladder wall has been reported as having been produced by tuberculous ulceration.

Symptoms and Diagnosis.—The skilful use of the cystoscope is the diagnostic factor upon which reliance is chiefly to be placed, and it makes the more indirect methods of establishing the presence of the vesical lesions unnecessary in many cases.

Pain and Vesical Tenesmus.—Painful, frequent urination and vesical tenesmus are the conspicuous subjective symptoms of tuberculous lesions of the bladder; nevertheless, these may all be present when the kidneys alone are involved in the infection; and, on the other hand, tuberculous lesions have been known to exist in the bladder without giving rise to any of them. The latter occurrence, however, is rare.

The patients with vesical tuberculosis present varying degrees of distress connected with the lesions, from irritability to intense vesical tenesmus and an almost constant desire to urinate. This may also be true in some of the cases of tuberculous infection of the prostate in which the bladder is not involved, though the writer has not seen any case in which the pain has been so very severe as that which is often present when the bladder is implicated.

As is true of the manifestations of the disease in other parts of the tract, so, too, in the case of the bladder, well-marked remissions of the symptoms may occur, which, in the writer's experience, is one of the most suggestive and characteristic features of the malady.

Vesical irritability is, in the larger number of the cases, the first sign which is noticed by the patient. After a variable period, pain succeeds irritability. In the patients seen by the writer, pain has not been noticeably increased at the end of the act of micturition, as it so conspicuously is in connection with vesical calculus. The patients have usually said that the worst pain was experienced when the bladder was full. It is generally continued for some time after the completion of the act of urination.

The pain is probably influenced by the location of the lesions in the bladder, those which are in the vesical neck giving rise to the greatest, and those near the superior surface of the viscus to the least distress.

Hematuria.—It is impossible to determine the source of the blood with any degree of certainty from the features which are so often stated to be characteristic of it. This is owing to the alterations in the character of the blood, which are often produced by the presence of one or another condition in the urinary tract. Vesical hemorrhage may, for example, fail to present, in cases of prostatic hypertrophy, the features which otherwise serve to distinguish it from renal bleeding; this is because of the long retention of the blood and urine in the bladder, caused by the enlargement of the gland.

It is true, nevertheless, in a general way, that a good guess may be made as to the source of the blood from certain characteristic features which mark the hematuria seen in the special conditions of the urinary tract which give rise to it.

Hematuria occurred as the first symptom in 20 out of 146 of the cases of Walker's series.

The writer has never seen an instance of profuse bleeding from vesical tuberculous lesions. It is said to have occurred in a few instances. Small quantities of blood in the urine are much more characteristic of this disease than of most other lesions of the bladder.

Microscopic blood will be found during the greater part of the course of the malady. In all descending infections from the kidney, which is to say, in far the larger number of all vesical tuberculous infections, the changes in the urine which are of the greatest importance will be due to the renal and not to the vesical lesions. This makes the urinary examination of but comparatively small importance as an aid in making the diagnosis, except with reference to the presence of tubercle bacilli in it.

Tubercle Bacilli.—Walker asserts that, when tubercle bacilli have been reported as being absent, it has been due to "inadequate examinations," and says that "a careful search will always reveal them."

It has already been noted in the earlier part of the chapter that tubercle bacilli in the urine do not necessarily mean the presence of a tuberculous lesion in the genito-urinary tract, and this is true of the bladder as well as of the kidney.

The case reported by Israel may be appropriately quoted here, in which the bacilli were twice found, and yet no tuberculous lesions were discovered in the genito-urinary tract at postmortem examination. Other cases of the same kind have been reported.

Cystoscopic Examination.—The only thing of which we wish to speak in this connection is the point of very great diagnostic importance, namely, the appearances of the bladder in cases of renal descending infection, in which the cystoscopic picture of the part of the bladder immediately around the ureteral orifice of one or both sides presents characteristic features.

Exacerbation of the Symptoms Produced by Passage of Instruments.—This is one of the most suggestive signs of the presence of the disease in the bladder. It has been very constantly noticeable in the cases in which the writer has had the opportunity to know the effect produced by instrumental interference.

The chief thing to be remembered in connection with the symptoms of vesical tuberculosis is that in the great majority of the cases it is

secondary to the same disease in the kidney, and in the other cases it is secondary to a focus in the lower parts of the tract.

Treatment.—The treatment of vesical tuberculosis comprises the various local methods which are directly applied to the bladder, and the more indirect manner of attacking the disease by nephrectomy, when the process is confined to one of the kidneys and the other one is functionally capable.

Before considering these measures in detail, we would say that attempts to cure the vesical lesions by such radical procedures as total extirpation of the bladder, which operation has twice, at least, been applied for the purpose, or the removal of a part or the whole of the mucous membrane of the organ, appear to us to be irrational, for the reason that vesical tuberculosis is practically never primary with reference to the rest of the genito-urinary tract, and is secondary to the same condition in the kidney in the very large majority of the cases. The chance of escaping a reinfection after denuding the bladder of a part or the whole of its mucous membrane, when the kidney is infected already and is constantly passing into it infected urine, is not great. Nevertheless, there have been a few cases in which cure is believed to have followed curetting of ulcerated areas in the bladder, and applying cautery or iodoform emulsions to them afterward.

In the only two cases in which the bladder was extirpated for tuberculous disease, death followed the intervention.

Treatment by Local Applications.—Ordinary irrigations of the bladder with cleansing fluids result, as a rule, in increasing vesical irritation and in causing a more rapid advance of the lesions. They are practically futile in the treatment of tuberculosis of the bladder and are often harmful.

The following local measures are strongly advocated by certain surgeons:

1. Instillations of solutions of corrosive sublimate.

2. Touching ulcerated areas with strong solutions of nitrate of silver by means of a swab, or by applying the solid nitrate of silver to the vesical lesions, by fusing it on to the end of a probe and introducing the latter through a Kelly tube passed through the urethra.

3. The injection of 3 per cent. solutions of thallin sulphate into the bladder.

The French school is the strongest advocate of the corrosive sublimate treatment. It is very painful, but the results claimed to have been procured by its employment, if true, certainly warrant a further trial of it.

The method of administering it is by the injection of a small quantity of the solution, beginning with 1 part to 20,000 of water, and increasing the strength to 1 part to 10,000 of water, if the effect is beneficial.

Thallin sulphate is claimed by some surgeons to be the most efficient of the means of overcoming vesical distress.

Some cures of tuberculous lesions have been reported as having followed the application of the nitrate of silver in the manner described above.

The Effect of Nephrectomy on Vesical Tuberculosis.—Reynaud,[7] Rovsing, Casper, Saxtorph, Le Fur, Halle and Motz, and many more have all given testimony in support of the beneficial and curative effect of nephrectomy upon vesical lesions of tuberculosis in cases in which the operation has been done when one kidney only was affected by the disease, and in which the vesical infection has been a descending one from the kidney as the primary seat of the disease in the genito-urinary tract.

The suppression of the original and of the continuous source of the infection from which the process at first proceeds and is subsequently, more or less constantly propagated to the bladder, is the most rational and logical method of treatment to adopt in the writer's belief.

This is not to say that all local measures in the bladder, which experience has shown to be of benefit, should be omitted as supplementary means of curing the malady there; but that to try to cure by local treatment a lesion which is constantly being subjected to reinfection from above, by the passage of infected urine over it, is not so likely to be beneficial or successful as to begin by removing the original focus of the disease and then, to direct the effort to curing the process in the bladder. It is the latter course that is counselled by us.

The usual general hygienic and climatic treatment should, of course, whenever possible, be brought to bear to help increase the patient's powers of resistance. Walker mentions a case in which vesical tuberculosis appears to have been cured by this means alone.

The following data of the comparative results of various methods of treatment are taken from the article of Walker, already cited.

Total number of cases, 477. Deaths, 161. Cured, 29. Improved, 130. Made worse, 6. Not improved, 77. Details lacking, 44.

Fatal cases: Treated operatively, 49. Operative deaths, 7.

Operative methods applied.	Cases.	Operative deaths.
Suprapubic cystotomy and curetting	28	3
Perineal section and drainage	10	3
Nephrectomies	5	
Nephrotomies	2	
Prostatectomies	3	1
Vesicovaginal incision	1	
Total	49	7

Cured, 29. Treated operatively, 20.

Surgical methods applied.	Cases.	
Suprapubic cystotomy and curetting or cauterizing, excision of areas	9	
Nephrectomies	8	
Nephrectomy and suprapubic cystotomy	1	
Curetting through female urethra	2	
		— 20

Other methods of treatment.	Cases.	
Local application of sublimate	2	
Local application of iodoform	1	
Climatic	5	
Medical	1	
		— 9

Improved, 130. Treated surgically, 67.

Surgical methods applied.	Cases.	
Suprapubic cystotomies, curetting, etc.	48	
With excision of ulcer	2	
Curetting through the female urethra	5	
Perineal section	5	
Vesicovaginal incisions	4	
Nephrectomies	2	
Cauterization through male urethra	1	
		— 67

Other methods of treatment.	Cases.	
Iodoform injections	23	
Sublimate injections	18	
Medical	10	
Climatic	2	
Tuberculin injections	2	
Guaiacol injections	1	
		— 56

Not improved, 77. Treated surgically, 48.

Surgical methods applied.	Cases.	
Suprapubic cystotomy and curetting	34	
Curetting through female urethra	10	
Perineal section	2	
Also same with suprapubic combined	1	
Excision of ulcer	1	
		— 48

Other methods of treatment.	Cases.	
Instillations of sublimate	15	
Instillations of iodoform	7	
Instillations of gemol	2	
Irrigations	3	
Medical treatment	2	
		— 29

Made worse, 9. Of these, 3 were treated by corrosive sublimate instillations; 2, with tuberculin injections; 1, with guaiacol injection; 3, with perineal section.

SUMMARY OF THE ABOVE DATA.—*Excision of the diseased area* was done in 13 cases through suprapubic cystotomy. There were 2 operative deaths; 8 later ones. One patient was not improved and 1 patient was improved.

	Cases.	Cured.	Deaths.	Improved.	Not improved.	Worse.
Nephrectomies	16	9	5	2		
Nephrotomies	2	..	2	..		
Suprapubic cystotomy curetting	121	9	28	48	34	
Curetting via female urethra .	17	2	0	5	10	
Perineal section	21	0	10	5	3	3
Vesicovaginal incision . . .	5	0	1	4	..	..
Total	182	20	46	64	47	3

Non-operative Methods.

	Cases.	Cured.	Deaths.	Improved.	Not improved.	Worse.
Injections of iodoform . . .	31	1	..	23	7	
Of sublimate	38	2	..	18	15	3
Of guaiacol	2	..	..	..	2	..
Gemol	2	..	..	1	..	1
Tuberculin	4	..	..	..	2	2
Climatic or medical	18	6	..	12		
Total	95	9	..	54	26	6

TUBERCULOSIS OF THE SEMINAL VESICLES, PROSTATE, EPIDIDYMIS, AND TESTIS.

It is rare to find the seminal vesicles the first part of the genito-urinary tract to be attacked by tuberculous infection. In the larger number of cases in which they are involved the disease has reached them by an ascending invasion from the epididymis through the vas deferens.

Keyes[9] holds the following views with regard to the manner in which the disease advances in the genital parts of the tract: "The weight of evidence goes to show that in many if not in all cases the prostate or vesicle is tuberculous before the testicle (epididymis) becomes so."

This opinion he bases upon the following statement:

"With a tuberculous testis (epididymis) the prostate is never normal, and is sometimes manifestly tuberculous to rectal touch. On the other hand, with a tuberculous prostate or vesicle, the testicle is not necessarily

involved. Involvement of the prostate precedes involvement of the second testicle. "

We are of those who hold the contrary view, in so far as the clinical evidence is concerned. In this we are sustained by the views of Senn and Councilman. We would not be understood as saying that this is always the case, but that it has, in our own experience, proved to be the fact, so far as clinical evidence is concerned, in the majority of cases.

The truth seems to us to be that there are too many exceptions to permit the conclusion that there is any hard and fast rule which can be laid down in regard to this matter. For example, let us note the following statements of Frisch and Zuckerkandl:[12] "Heuter, in a case of the early stage of prostatic tuberculosis, found tubercles in the posterior urethra, in the urethral mucous membrane in the immediate neighborhood of the ducts of the prostatic glands." And, again: "In advanced tuberculous disease of the prostate the bladder is seen to have been infected by direct passage of the process through the posterior urethra; and in many instances we see the posterior urethra and vesical neck equally occupied by deep-seated cheesy ulcerative processes, so that it may happen that the urethra and vesical outlet have no line separating the one from the other."

These authors also cite the two following cases, which are of interest in this connection:

"A patient had his right testicle extirpated because of tuberculous disease in it. The right kidney, several months later, was found to be also involved in the same process. It, too, was removed. The only other part involved was a small portion of the bladder immediately around the right ureteral vesical orifice.

"Another had a tuberculous kidney removed. The mucous membrane of the ureter and the trigone of the bladder were found to be implicated in the process also. Several months afterward the epididymis became tuberculous without either the prostate or the seminal vesicles being involved."

In the writer's own experience there have been 12 cases in which, so far as the most careful examinations could determine, the tuberculous infection began in the epididymis or the testis of one side. In 4 of these patients there was an extension to the vas and the seminal vesicle of the same side, without any evidence being shown that the prostate had been involved. In none of the other 8 did the process advance beyond the epididymis or testis. In the first 4 there were 2 patients who finally developed tuberculous prostates and vesical tuberculosis. These patients died. There was no postmortem examination in either.

The 8 surviving patients have been under observation for periods

varying between eight and twenty-three years. In no instance has the disease advanced beyond the epididymis or testis of one side. There has been positively no trace of invasion of the prostate in any case.

The writer has seen in his own experience but 3 cases in which he felt fairly well assured that the disease was present in the prostate as the only part of the tract below the bladder to be involved. In these it is probable that the kidney was infected in each instance and the bladder was apparently free from infection in 2 of them. In the other it is known to have been implicated.

Here, then, we have evidence to show that the disease may be manifested independently at either end of the tract with an interval of time between its manifestations at either point, the kidney and the epididymis. Also it is clearly shown that an epididymis infection may follow—we do not mean that it necessarily resulted from—a renal infection of the same side after an interval of time and *without implicating either prostate or seminal vesicle;* and yet, again, that the process may begin in the epididymis or testis and remain localized there without ever involving any other part of the tract (twenty-three years in one case observed by the writer).

According to the experimental work (quoted by Zuckerkandl and Frisch[12]) of Baumgarten and Kraemer, it appears that from a posterior urethral infection the process is *never* propagated through the vasa deferentia to the epididymis, while infection of the vas or seminal vesicle *does* extend to the urethra. That infection of the bladder never ascends to the kidney. In fact, that an advance of the process *never takes* place *against* the direction of either urinary or seminal current. Directly opposed to this are the experiments of Paladino-Blandini, which indicate that the tuberculous as well as other microörganisms placed just within the external urethral meatus *do* infect the deeper parts of the tract by direct extension backward along the urethra and *directly against* the urinary current.

All that can be said with any degree of confidence of the travelling propensities of the tubercle bacillus in the genito-urinary tract is that it enters it in the great majority of cases via the kidney and travels downward *with the urinary current by preference*, and mounts from below with reluctance, *if at all, to* the kidney, when it enters by the lower parts of the tract in the first instance.

It has been shown by the foregoing data that there is evidence that the disease remains localized in the epididymis or testis, or both, in some cases, while in others it extends.

When the testis and epididymis are implicated the prostate is not necessarily involved as well, as has been stated by some observers; at any rate, when the affection is unilateral.

The seminal vesicle is rarely the first part of the tract to be invaded by the infection. In Walker's series there were but two instances in which it was the starting point of the disease.

In short, it is evident that there are several points through which the invasion may take place, and its advance in the tract may be made in more than one direction.

Pathological Anatomy of the Lesions in the Seminal Vesicles, Prostate, Vasa Deferentia, Epididymis, and Testis.—It has seemed to us to be more convenient to consider the disease as it appears in the above-named parts under one heading.

Pathological Anatomy of the Process in the Vesicles.—The lesions begin with the scattered tubercles in the distal part, or the mouth of the vesicle, at first, extending later to the remainder of it. As elsewhere in the mucous membrane of the genito-urinary tract, here, too, there soon occurs a confluence of the tubercles, resulting in ulcerative, cheesy areas, involving more or less of the whole surface of the vesicle. These lesions subsequently extend in depth, involve the submucous tissue, and also the external covering of the vesicle, in some cases perforating it, in others becoming calcified and inert. Small foci of pus are found in and outside of the wall of the vesicle. These may perforate the wall, and the pus, burrowing, may end in forming a fistula communicating with the rectum or the surface of the perineum.

In one of Weichselbaum's cases (quoted by Warren[13]) one of the large veins of the pudendal plexus was perforated by the tuberculous process in the vesicle.

A noticeable feature of the lesions in the vesicles is the large exudation which takes place around them in most instances. Owing to this the outline of the vesicles is obscured, and it is difficult to detect them by rectal touch. An erroneous diagnosis is often made in consequence of this fact, the condition being believed to belong to the prostate, and the seminal vesicles being overlooked.

Lesions of the Prostate.—In its early stages tuberculosis of the prostate appears in the form of more or less numerous small foci of cheesy character. Subsequently these become liquefied and confluent, and may convert the whole of one, or of both lobes, into a single abscess. In other instances there is a calcification of the foci and the process comes to a standstill.

In the cases in which there are extensive abscesses the pus may break through the outer fibrous sheath of the gland and make its way into the rectum, or to the surface of the abdomen above the symphysis, or to that of the perineum. Occasionally the pus burrows upward between the rectum and the bladder, and may break into the peritoneal cavity.

The Vas Deferens.—The gross appearances presented by tuberculosis of the vas are: thickening of its walls, the presence of scattered tubercles in its peripheral parts, well-marked exudation around the vas in some instances; in others, cheesy nodules are scattered more or less abundantly throughout its walls.

The Epididymis.—The disease appears in the epididymis, first as a hard nodule, the character of which is described by Warren[13] thus:

FIG. 454

Tuberculous lesions of the testis. (Warren Museum.)

"On section, the nodule presents a grayish-red, firm, homogeneous mass without well-defined boundary, but shades off into the surrounding connective tissue. In this tissue (of the nodule) are seen the round or oval shrunken cylinders of the canals. As the disease progresses a number of these nodules form. The canals are filled with broken-down material and are distended considerably. Occasionally, when these nodules soften, there form in the adjacent tissues small abscesses which frequently break and become fistulous openings."

The Testicle.—The same writer gives the following description of the conditions presented by a tuberculous testis:

"The disease shows itself at first as one or two large nodules which may involve the whole or a large part of the organ. These nodules soften down in the centre and form small abscesses which break and form fistulæ.

"When the whole testicle is involved a section shows it to consist of a gelatinous, homogeneous tissue, in which lie several yellow, cheesy masses of stellate or irregular shape.

"According to Kocher, a microscopic examination of the tubercles in the earliest stages of their development shows within the seminal ducts

a collection of giant cells and epithelioid cells, supported between two layers of the membrana propria and filling out the lumen. The intra-canalicular masses undergo cheesy degeneration, at which time the new tubercle is found in the membrana propria.

"The bacilli have been found in the seminal ducts and in the semen of patients affected with pulmonary tubercle, in whom the testes showed no sign of disease. The microörganisms are carried to the organ in this case through the bloodvessels and are transported through the epithelium of the canals into the lumen."

The Urethra.—This part of the tract is not frequently affected. We have already noted that it may be so, however, when referring to the description of the appearances by Frisch and Zuckerkandl.

Symptoms and Diagnosis of Tuberculosis of the Vesicles.—The symptoms of the disease in these structures are: Bloody seminal emissions, in the early part of the course of the malady; increased sexual desire, and, at some time during its course, vesical irritability, which, however, presents no distinctive features by which the tuberculous nature of the malady would be suggested.

Objectively, when the nature of the process is not disguised by exudation about the vesicles and the posterior surface of the prostate, the vesicle may present a more or less characteristic induration or nodular condition, or an area of fluctuation, together with general enlargement of the vesicle, when examined by the finger in the rectum.

These symptoms may all occur in connection with non-tuberculous lesions of the vesicle, and none of them can be regarded as really distinctive of tuberculosis. When, however, they appear in the absence of gonorrhœa or other inflammatory infection, if there are evidences of tuberculosis in other parts of the genito-urinary tract, especially if in the prostate, epididymis, or testis, or if bloody seminal emissions occur, or if tubercle bacilli are found in the seminal fluid, we may be practically assured of the diagnosis.

Treatment.—Massage, hot rectal irrigations, and local applications to the posterior urethra are not only unavailing but are injurious. The only measures which are likely to be beneficial or curative are the climatic or hygienic ones, or the application of radical surgical treatment.

Surgical Treatment.—The evacuation of pus from abscesses of the vesicle will give relief from pain and will lessen temporarily the constitutional disturbance which arises from retained pus. The only measure which offers any prospect of cure is that of excision of the affected vesicles in the cases in which the disease in other parts of the tract or of the body is not of such extent as to make the radical measure upon the seminal vesicle futile.

The following cases indicate the prospect that is offered by the adoption of this treatment:

Mansell Moullin[14] reports 2 cases of excision of the vesicle for tuberculous disease which had extended upward from the epididymis. The operations were done through the perineum by an open dissection. The first operation was followed by prompt healing; the second one resulted in recovery with a small persistent fistula.

According to Legueu,[15] 40 operations had been done for the removal of tuberculous seminal vesicles prior to 1905, the first of them having been performed by Ullmann. Legueu has operated for the condition six times. His first operation was in 1901. In 5 of these cases he selected the perineal route of approach to the vesicles, the inguinal in one. In 4, both vesicles were removed; in 2, only one of them. The whole or a large part of the prostate was taken away at the same time in all the cases. In all but 1 instance the results were favorable. One patient had infection of the wound and a secondary hemorrhage after the operation.

The later results were as follows: In 1 case, the operation was of recent date; one patient died a year after the intervention from pulmonary tuberculosis. The four remaining patients were operated upon one, three, three, and four years previous to the report. All of them were in excellent condition, and the disease appeared to have been arrested.

Symptoms and Diagnosis of Tuberculous Disease of the Epididymis and Testis.—As the condition appears clinically the first seat of the process is the head of the epididymis. In almost all cases the epididymis appears to be the first seat of the disease with reference to the testis, and in some it does not involve the testis at all. The postmortem findings, however, indicate that the testis is implicated in about two-thirds of all the cases in which the epididymis is the seat of the affection.

The onset of the disease may be either sudden or insidious. More frequently it takes the latter form.

The symptoms, in the first method of invasion are very similar to those of an acute gonorrhœal infection, viz., the signs of acute inflammation: swelling, redness, heat, pain, tenderness, and induration. In these cases it is often impossible to determine by touch whether or not the testicle is implicated.

The acute inflammation, instead of subsiding within a week or two, as it does in cases of acute gonorrhœal infection, persists. Pain, however, does not continue; after a variable interval, during which the swelling remains stationary, one or more areas of fluctuation appear, and presently pus breaks through the surface of the scrotum at one or several points, and discharging fistulæ are established. The pus coming

from these is at times cheesy. In some instances the central abscess progresses very slowly.

When the fluid in the sac of the tunica vaginalis is not too large in quantity there can usually be made out a number of nodular masses in the course of the epididymis. The vas is also enlarged and hard. The testicle itself presents more or less irregular areas of hardness, often associated with soft spots in other parts of the organ. Sooner or later the process reaches the surface and discharges, establishing sinuses, which alternately open and close, for variable periods.

In the acute stage, at the onset of the disease, the constitutional symptoms are marked and similar to those seen in connection with the other acute testicular infection of which we have spoken. They may soon be replaced by less active manifestations of the disease, but in some cases do not wholly disappear. When this is the case, they are usually referable to tuberculosis in other parts of the organism, which in many cases is associated with the disease of the testis and epididymis.

In *the second and more common form of attack* the patient is not conscious of any marked general or local disturbance. Sometimes there are no symptoms at all, other than the presence of a hard nodule in the epididymis or testis, which is accidentally discovered by the patient or by his physician in the course of a routine examination; in other cases there is moderate aching pain in the affected testicle or epididymis, and more or less sexual excitability. The latter is, however, much more suggestive of prostatic or seminal vesicle involvement.

The progress of the nodule in the epididymis or testis, or of nodules in both organs, is often very slow. In some instances they occupy years—five to ten—in coming to the point of discharging on the surface; in some they never do so, but, after having shown areas of softening, the fluid is absorbed and the parts implicated gradually undergo fibrous changes, which in some instances result in entire arrest of the tuberculous process.

In those cases in which the disease originates elsewhere in the tract and involves the testicle and epididymis secondarily, the symptoms which characterize the presence of the malady in the other parts will often mask those of the epididymis and testis, except, of course, in the cases in which the invasion is in the acute form.

The diagnosis of the disease, when it occurs in its insidious form, may be impossible for a long time. It is always a suspicious circumstance when a nodule exists in the epididymis, and when, so far as can be determined, the patient has never had gonorrhœa, and also if there is long persistence of such a nodule, even if there has been gonorrhœa. It must be confessed, however, that the presence of such a nodule alone warrants nothing more than suspicion. If, in addition to it, there are

nodules or areas of softening in either seminal vesicles or prostate, and especially if there co-exist with them more or less well-marked discomfort and frequency of urination, the suggestion of tuberculosis is greatly strengthened. If there is a gradual increase in the size of the nodule, and, above all, if fluctuation can be detected in it, the diagnosis is practically assured.

In the acute form of the invasion there is ground for suspicion that it is of tuberculous nature when the attack does not arise in connection with mumps, gonorrhœa, syphilis, or stricture of the urethra.

Treatment.—The writer frankly confesses that there is no subject in the range of surgical diseases of the genito-urinary tract with regard to which he is so much in doubt as that of the treatment of tuberculosis of the epididymis and testicle. The data derived from the different sources are exceedingly conflicting, and so are the facts which he has observed in some of his cases. The doubt is with respect to whether or not castration, or expectant, hygienic, and climatic treatment should be applied in certain of the cases. These are the ones in which, so far as can be determined, the process is as yet limited.

In the personal experience of the writer there are ten patients who have been under observation for periods varying from eight to twenty years, and all but one of whom are alive and well today. No radical operation has been done in any of these cases. In four of them minor surgical measures have been applied; in two, abscesses of the epididymis were opened, cleansed, and packed with iodoform gauze; in one instance an abscess of the glands of the groin was treated in the same way, and in the fourth case a tuberculous focus of the testis was subjected to this treatment. All these ten patients have lived in good hygienic conditions. In the course of the times mentioned there has been scarcely any extension of the disease to other parts than those originally implicated. When other similar cases are added the number of patients becomes considerable, and furnishes good grounds for the belief that arrest of the process will often take place when the conditions under which some of the patients referred to above lived and have been cured, can be secured. On the other hand, we have series of successful results from radical surgical treatment, such, for example, as that furnished by the Tübingen clinic of Bruns, and reported by Haas.[16] These were as follows: 111 patients, upon whom either single or double castration had been performed, were examined at periods subsequent to the operations, varying from three to thirty years. In 78 of the cases one testicle and in 33 of them both testicles were removed. The vas was divided high up in all the cases. In 26 per cent. only of the unilateral castrations did the disease appear in the other testicle later, and but 9 per cent. of the same patients died of tuberculosis of the urinary tract. Most of the latter number had

shown evidence of tuberculous disease of other parts of the tract previous to the operations.

Cure followed the unilateral castrations in 44.6 per cent. of the cases.

Of the 33 patients who were submitted to double castration, 56 per cent. were cured, 15.6 per cent. died within the first three years afterward from genito-urinary tuberculosis in some form or other.

The mortality, therefore, of complete castration within the first three years after the operation was nearly twice as great as that seen in connection with the unilateral operation in the same period; but, on the other hand, the percentage of cures among the patients upon whom complete castration had been performed and who survived more than three years afterward was noticeably greater than with the corresponding patients upon whom unilateral castration was performed.

One thing is clear, viz., that castration is contra-indicated when there is evidence of the existence of tuberculous disease in the bladder, kidneys, seminal vesicles, or the prostate.

Theoretically the cases of unilateral tuberculosis, in which the disease appears to be limited to the epididymis and testicle, should offer the best chance of cure by removal of the parts affected. Were it not for the favorable results obtained in many instances from hygienic treatment, and the spontaneous arrest of the process in some even of the cases of patients whose surroundings are not favorable, and were the results of castration less good than in such series as that reported by Haas, there would be less room for doubt as to the course that it is best to pursue.

What the relative proportion of good and bad results derived from palliative and from radical surgical treatment, respectively, may be it is impossible to learn. Largely on this account both plans find strong advocates and both strong opponents.

In a certain number of cases the removal of one or of both testicles appears to have been the cause of a sudden extension of the disease in the form of acute miliary tuberculosis which has ended fatally. But few experiences of this sort are required to make the surgeon hesitate before counselling castration, even when the conditions presented seem favorable to success; especially is this true if he has seen cure or arrest of the disease take place in a considerable number of cases without operation.

Less Radical Surgical Measures.—In the cases in which the upper part of the tract is involved, indeed, in those in which it is not, it is desirable to open abscesses in the epididymis or testis when they occur, and to pack the cavities with iodoform gauze or with gauze soaked in a 10 per cent. glycerin emulsion of iodoform, after curetting and cleansing them, in all cases in which it is undesirable to perform castration.

Subcutaneous injections of the glycerin emulsion of iodoform into

such diseased areas are said to have good results. Lannelongue has advocated the employment of a 10 per cent. solution of choride of zinc in the same manner.

Ligature of the spermatic cord, suggested by Pousson, requires the test of further experience before its value of the contrary can be determined.

In 2 cases the writer divided the vas in the groin and injected emulsions of iodoform into it, the divided end of the canal leading to the epididymis and testis being sutured to the skin and kept open by the occasional passage of bougies. The other end of the vas was ligated. The effect of the treatment, in one instance, was decidedly favorable; in the other, it appeared to exercise no beneficial influence.

On the whole the writer inclines to the opinion that it is a mistake to remove either or both testicles, except for the sake of cleanliness and comfort in the cases in which there is distressing open ulceration or suppuration, and to advise hygienic, tonic, and outdoor treatment for the larger number of these patients.

The most important part of the outdoor feature of the treatment is that of sleeping in the open air. This can be contrived, even in harsh climates, if a little ingenuity is used. Canvas screens, which can be moved in correspondence with the changes of the wind and in such way as to prevent rain or snow from entering, are not difficult to contrive, and a small balcony or piazza or flat roof is available in most cases.

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